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MILITARY HYGIENE

- USSR -

[Following is a full translation of the Russian-language monograph Voyennaya gigiyena (Military Hygiene), Moscow, 1959, Military Publishing House, Ministry of Defense USSR, pages 1-367. Author of the monograph is F. G. Krotkov.]

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NOTE

The book reflects the present state and achievements of Soviet hygiene and medical practice.

It shows in detail the responsibilities of the army doctors in providing sanitary and hygienic protection for personnel in peace and in war. It describes the measures designed to prevent disease, protect health, and create the most favorable living and working conditions depending on the nature of activity of the troops.

The book examines the problems connected with the hygiene of food and water supply, air hygiene, hygiene of armored troops, radiation hygiene, and protection of air, food and victuals, water and sources of water supply, and other objects in the environment from radioactive and poisonous substances and bacterial preparations. Decontamination, degasification, sanitary processing, and control over execution of these measures are other problems treated.

The book contains many sketches and tables of reference value.

The book is intended for all officers of the medical service of the Soviet Army. It may also be used as a textbook by students in military medical schools, students in medical schools taking military training, hygiene teachers, and civilian physicians.

INTRODUCTION

Military hygiene is one of the oldest branches of medicine.

The earliest information on sanitary measures among soldiers goes back to remotest antiquity. These measures include instructions for keeping encampments, water supplies, and food clean, disinfecting booty seized from the enemy, etc. Elementary ideas on the importance of prophylaxis were known to the Persians and Greeks long before our time. Sanitation among the troops of ancient Rome was at a relatively high level of development. The classical writings include a description of sanitary measures among the Roman legions: purification and sanitation of encampments, supplying the soldiers with good water, means of preventing infectious diseases. After the fall of the Roman empire all the achievements of antiquity in the field of military hygiene became forgotten for a long time.

The appearance of firearms brought about changes in the system of organizing and equipping armies. Doctors were drawn into armies and made responsible not only for treating the sick and wounded, but also for the sanitary condition of the places where the troops were stationed. Numerous observations of the course of epidemic diseases led to the establishment of a direct connection between the sick rate of the soldiers and the sanitary condition of their posts, purity of water and food, and sick rate of the population in places where they were billeted. It was shown that clean air in living quarters for soldiers was important and that pollution of encampments was a factor in the outbreak of dysentery. Methods were proposed to disinfect sewage with lime and purify water by boiling.

In 1681 R. Faure made an attempt in his book Military Medicine to define the hygienic tasks of army doctors. According to the author, the army doctor must above all be a hygienist who is required to point out to the commanding officer the defects in sanitation that threaten the soldiers' health and to recommend measures to overcome these defects.

One of the earliest Russian works on military hygiene, published in 1775 by A. G. Bakherakht, mentioned the following rules: "good rest and good food, fresh and dry air, adequate clothing, movements and work commensurate with bodily strength, and a reasonable amount of rest at night." These hygienic instructions are still valid almost two hundred years later.

The great Russian commander A. V. Suvorov paid a good deal of attention to the health of the soldiers. Fully realizing that it was easier to prevent illnesses than to treat them, he demanded that his subordinates "be constantly solicitous of the health of healthy soldiers."

In an order dated 16 May 1778 Suvorov demanded that attention be paid to the quality of food and drink, correct fitting of uniforms and shoes, that the [Russian] soldiers' "food and drink, construction of barracks and dugouts, space and crowding, cleanliness, cooking dishes, and exhaustion of all kinds be checked."

During the Patriotic War of 1812 Russian army doctors were fully aware of the importance of hygienic measures among the troops. They knew the reasons for such wartime mass diseases as scurvy and how to combat them. The instructions dealing with control measures mentioned the insufficiency of fresh vegetables and sauerkraut as the main cause of scurvy, which was fairly prevalent at that time.

One of the founders of military hygiene as an independent discipline was Professor M. Ya. Mudrov of Moscow University. In his "A Word on the Use and Objects of Military Hygiene or the Science of Protecting the Health of Soldiers" delivered on 30 July 1809 on a ceremonial occasion of the university, Mudrov stated that "it is the duty of regimental and divisional doctors not so much to cure illnesses as it is to prevent them and, above all, to teach soldiers to protect their own health."

The objectives of hygienic protection of the troops were reflected in Professor Mudrov's book The Use and Objects of Military Hygiene. This book did much to promote the protection of health in the army.

Russian army doctors during the Napoleonic wars were fully aware of the importance of hygienic measures and knew how to carry them out. For example, Il'ya Enegol'm's book on military hygiene published in 1813 contained specific instructions on troop disposition, food, water supply, work and rest routines.

A. A. Charukovskiy published his Field Medicine (1836) in which he summarized the experience of the Patriotic War of 1812. He described the requirements for outfitting and feeding soldiers, quality of air in the barracks, and water supply. The original chapters in the first part of the book dealing with tropical and polar hygiene are exceedingly interesting. Charukovskiy took up in detail the method of purifying water with coal dust. "When the coal and sand settle to the bottom of the vat," he wrote, "the water becomes clean and has no odor or taste."

R. S. Chetyrkin was an outstanding expert on hygiene in the Russian army in the middle of the 19th century. It was under his direction that numerous manuals were prepared and issued on all types of activities of military doctors, veterinarians, and pharmacists.

In his "Instructions in Connection with Applied Military Medicine" issued in 1850, Chetyrkin gave a modern explanation for the development of scurvy among the troops: "lack of vegetables, sauerkraut, beets, kvass, prolonged consumption of corned beef or salted fish; exhausting work with insufficient rest and poor food; dirty, damp, and cold quarters."

The responsibilities of Russian army doctors for protecting the health of the soldiers were defined by the second half of the 19th century. They were expected to inspect the feeding of the enlisted men, quarters in barracks and camps, and give regular medical examinations. Moreover, they watched carefully to see whether "the soldiers maintained cleanliness, frequently changed their underwear, and took baths."

The idea of hygiene having a "social aspect" was formulated in 1862 by the hygiene teacher in the Medical and Surgical Academy, Professor Ya. A. Chistovich* [*Hygiene was taught during the 1860's in the department of forensic medicine of this academy] who wrote that "hygiene is chiefly an applied science that can confer direct and obvious advantages only when it penetrates deeply into the life of the people."

The outstanding Russian hygienist A. P. Dobroslavin in formulating the tasks of hygiene demanded that "a study be made of the conditions for ensuring the maximally useful activity of man and that an effort be made to determine the circumstances affecting labor favorably or unfavorably and to find the means of strengthening or eliminating them, as the case may be."

The views of the prominent Russian medical scientist N. I. Pirogov were highly important in promoting military hygiene in our country. In his Principles of Military Field Surgery he wrote: "I believe in hygiene. That is where the true progress of our science lies. The future belongs to preventative medicine. This science will confer undoubted advantages on mankind." These remarkable thoughts were expressed at a time when hygiene was mainly a descriptive discipline whose ideas were based on observation rather than on experimentation.

The achievements of experimental hygiene based on the works of Maks Pettenkofer, A. P. Dobroslavin, and F. F. Erisman laid the scientific foundation for the sanitary and hygienic measures introduced among the troops. The development of laboratory methods of investigation bolstered the army doctors in the struggle for healthy living and working conditions of the soldiers in peace and in war. At the same time it became possible to establish hygienic standards so necessary in the army where the lives of the soldiers are strictly regimented by rules and regulations. Progress in experimental hygiene made it possible to set up scientific norms for barrack and camp construction, ventilation of defensive and non-defensive installations used by troops; to argue effectively for proper rations in peace and in war; to determine the requirements for drinking water and preparation of food.

Sanitary experience gained during the Crimean War (1853-1856) advanced military hygiene in Europe. Research was largely along the lines of identifying the causes of high morbidity among the troops with a view to working out scientific measures to protect their health and to prevent infectious and non-infectious diseases.

The regulations and manuals of European armies and the statutes for the medical section of the Russian army paid increasing attention to the organization of sanitary-hygienic measures among the troops. All aspects of living conditions were made the responsibility of medical personnel: disposition in the barracks, dugouts, and tents; protection of water; preparation and distribution of food; fitting of uniforms and shoes. Sanitary supervision was assigned to the army doctors and they were expected to have serious training in hygiene.

During the Russo-Japanese War (1904-1905) army doctors were helped for the first time in the history of warfare by the organization of laboratories (five) and mobile disinfection detachments (nine). Medical headquarters included two physician-hygienists and physicians for special assignments. The physician-hygienists and sanitary detachments had field laboratories at their disposal.

In accordance with the instructions issued by the Commander-in-chief, doctors of the sanitary detachments were freely admitted to all army units and installations "to investigate sanitary-hygienic conditions as well as the extent and nature of the sick rate."* [*Voyna s Yaponiyey 1904-1905 gg. Sanitarno-statisticheskiy ocherk (The War with Japan, 1904-1905. A Medical Statistical Survey), 1914, p. 205.]

The scope and activity of the sanitary detachments included: soil pollution, water supply of troops, laboratory analysis of water, sick rate of the local population, system of removal and disinfection of sewage, procedure for slaughtering cattle, sanitary supervision of the preparation and distribution of food, observation of bread baking, control of personal cleanliness and organization of bathing, "sanitation of battlefields after major engagements."* [*Order of the Commander-in-chief 3 December 1904.]

Professor I. P. Skvortsov published his Military Field Hygiene during the Russo-Japanese War. This work reflected the experience gained in providing sanitary-hygienic services for the troops under field conditions. The author wrote that hygiene in protecting the health of soldiers is interested in what and how a man is clothed, where and how he spends his time, what and how he is fed, and how he moves from place to place as well as in the circumstances under which he requires medical treatment and especially what causes illness."

A powerful impetus to the development of military hygiene was provided by World War I. The vast scale of the war which led to the mobilization of millions of men demanded efficient organization of sanitary measures by the medical service. Organization of these measures among the troops in the field army required a great many hospitals and mobile sanitary facilities set up by the army, Red Cross, Union of Cities, and All-Russian Zemstvo Union.

A substantial number of bacteriological, hygienic, and other laboratories had to be created to provide sanitary facilities at the front.

Exhaustion of the food resources of the warring countries made it necessary to re-examine the nutrition norms of the field armies and storage methods. Many new foods were introduced (lentils, soybeans, new types of fats). The hygienists were extremely helpful in the laborious and important work of reviewing the food rations and approving the new food products.

Supplying troops in the field with water during the war was a complex problem, especially during the first two years when there were mass intestinal infections (cholera, typhoid). Russian hygienists

had to share in the task of developing and introducing methods of purifying and disinfecting water as well as in organizing sanitary supervision of purification apparatus.

The appearance on the battlefield of a new type of weapon -- poison gases -- raised new problems in sanitation: (1) elaboration of hygienic standards for antichemical shelters; (2) detection of poison gases in water and food; (3) elaboration of methods of protecting sources of water and food supplies from contamination by gases; (4) decontamination of water and food; (5) organization of sanitary processing of personnel in the event the enemy used persistent poison gases.

The Red Army inherited from the pre-revolutionary army a disorganized medical apparatus that was totally unsuited to function under the conditions of a mobile civil war. The foundations of the medical service of the Soviet Army were laid amidst the ruin, military intervention, and bitter struggle with the counter-revolutionaries.

During the civil war Soviet hygienists took an active part in carrying out health measures at the front. They were very much concerned at that time with the control of infectious diseases: typhus, recurrent fever, and intestinal infections.

The hygienists helped to work out for the first time nutritional standards for units at the front and in the rear. Substantial attention was paid to the purification and disinfection of water. In some places at the front scurvy was a serious problem.

The lack of authorized equipment made it necessary for army doctors to improvise apparatus (filters and devices to purify and disinfect water, disinfection chambers, etc.).

After the civil war ended, personnel in the medical service switched their efforts to improving the working and living conditions of the soldiers. They inspected barracks and camps, studied the feeding of troops, handled problems concerning water supply and sanitary maintenance of military posts. They stressed training on the basis of a physiological-hygienic evaluation of work and rest conditions among various kinds of troops.

The Military Medical Academy played a prominent part in providing scientific solutions of the numerous problems confronting the medical service during those years. The Central Psychophysiological Laboratory (later the Scientific Research Sanitation Institute of the Workers' and Peasants' Red Army) and district laboratories were also active.

Hygienic protection of the Red Army was based on experimental investigation and sanitary inspection of working and living conditions in infantry, cavalry, artillery, and technical troops, the air force, and armored units. The extensive research and inspections carried out by the departments of the Military Medical Academy, Scientific Research Experimental Sanitation Institute of the Red Army, district laboratories, and army doctors led to the formulation of hygienic standards and principles of providing sanitary-hygienic service for troops in camps

and in the field. The results found their way into the regulations and manuals of the Red Army, Guide for Protection of Troops against Epidemics, Guide for Field Supply of Water, Guide for the Organization of Nutrition and Preparation of Food, manuals for the design and construction of military cantonments, barracks, and camps. The Military Sanitation Handbook for Doctors and the first textbooks on military hygiene (M. A. Ivanov and F. G. Krotkov) were published at that time.

During the prewar years authorizations were worked out for various kinds of equipment: hygiene laboratories and installations, field kits to test water and food, indicator kits, devices to measure chlorine and coagulating agents, etc.

Unlike the situation in World War I, the Red Army had at the beginning of World War II manuals on all branches of preventive medicine. The army doctors were much better trained in hygiene than were their predecessors in World War I. The vast scale of operations necessitated the creation of an orderly system of military hygiene capable of coping with tasks requiring scientific competence in hygiene. The experience of the first year of the war demonstrated the need of mobilizing all the scientific resources of the country in behalf of the troops.

During the second year, posts of front-line and army sanitary inspector-hygienists were set up. These men were responsible for nutrition and water supply, quartering of troops in the field, particularly in fortifications, prevention of frostbite, and personal hygiene of the soldiers. Hygiene among the armored troops and in the air force was a special object of concern. While active military operations were going on army and front-line hygienists supervised measures to cleanse inhabited localities liberated from the enemy and to restore the water supply. Never before had hygienists been so deeply involved in the discussion and solution of sanitation problems as they were during World War II.

All hygienic measures were carried out by army and front-line inspectors in direct cooperation with hygienic sections of Sanitary-Epidemiological Laboratories and of Sanitary-Epidemiological Detachments. The latter were charged with obtaining sanitary intelligence, which was unusually difficult after the battle of Stalingrad when the Red Army began the planned liberation of the territory temporarily occupied by the enemy.

A new era in the history of military hygiene began after the victorious conclusion of the Great Patriotic War 1941-1945. This period is marked by the influence of I. P. Pavlov's physiological teaching on the development of thinking on hygiene in our country. This physiological stress distinguishes Soviet from foreign military hygiene where the main concern is with problems of technical nature.

The appearance of new means of warfare, atomic and bacteriological weapons, the growth and perfection of military chemistry pose a number of new problems for military hygiene. These include indications of chemical and bacteriological attack, execution of measures for deactivation,

decontamination, and disinfection of water and food supplies, participation in the organization of sanitary processing of people along with their equipment and arms, hygienic eradication of the effects of enemy use of mass means of contamination.

World War I was responsible for the rise and rapid development of aviation medicine and hygiene of special troops. The end of World War II was marked by the rise and rapid development of a new branch of hygiene -- radiation hygiene. The use of nuclear weapons causes radioactive contamination of the atmosphere, which is the object of attention and study on the part of hygienists.

CHAPTER I

BARRACKS HYGIENE

Introduction

Man spends most of his life within the walls of buildings of one kind or another. Consequently, the construction, properties of building materials, sanitary-technical equipment, and operating conditions are of considerable hygienic importance since they influence man.

The relationship between the sick rate of the population and quality of the houses has long been established. Unhygienic, damp, and dark rooms promote the spread of such diseases as tuberculosis, intestinal and children's infections, and influenza. The relationship between the high general sick rate of soldiers and poorly constructed or overcrowded barracks was noted by army doctors back in the nineteenth century.

Recent investigations have revealed that houses, hospitals, schools, theaters, and concert halls invariably contain a great many microorganisms, including those of the pathogenic kind.

Research on dust in the air of closed rooms and bacterial seeding has shown that the number of bacteria increases with the amount of dust. That is why the fight against dust in barracks, schools, and hospitals is also a fight against bacterial contamination of the air. To decrease the amount of dust and microorganisms in living and study areas, hospitals, and clubhouses, filth must be prevented from entering the buildings (with shoes and clothes) and effective ventilation provided. Sometimes physical and chemical means of disinfecting the air have to be used.

Polluted air in poorly constructed, unventilated, and crowded buildings not only threatens the people with infection, but also increases shallow breathing, interferes with cardiac activity, impairs thermoregulation, causes insomnia, etc. These are the consequences of violating hygienic standards in the construction and maintenance of living quarters.

Before erecting barracks it is necessary to select an appropriate site, carefully lay out the buildings with due regard for hygienic considerations in orienting the living and study rooms to the compass points, provide architecturally attractive exteriors and interiors and landscaping. Lighting, heating, and ventilation must come up to hygienic standards.

Historical Sketch

In 1724 Peter I ordered the construction of company or batallion settlements and regimental yards to quarter the troops. A separate hut was set aside for each sergeant, one hut for two noncommissioned

officers, and one hut for three privates. The construction was based on the historical experience of quartering the Musketeer and Boy-soldier regiments — Preobrazhenskiy and Semenovskiy — in settlements.

Peter I decided to build settlements because of the need to strengthen troop morale. He was also influenced by the desire to free the people from the oppressive burden of billeting the soldiers.

Modern barracks construction in Russia dates back to the end of the eighteenth century. In 1798 construction of the Semenovskiy barracks was started on the land of the Semenovskiy settlement; a year later the foundation of the building for the Izmailovskiy barracks was laid. Barracks in Petersburg were of the wide central corridor type. This kind of barracks was erected in the middle of the nineteenth century for the Moscow regiment too. Barracks were erected in Moscow with a side corridor: the Khamovnicheskiy and Pokrovskiye barracks.

There was large-scale construction of the corridorless type in Russia from 1874 to the beginning of World War I in 1914.

Barracks construction started in the Soviet Union in 1924. The new ways of organizing the armed forces and new methods of teaching and training troops required new principles of designing barracks.

Modern barracks differ markedly from those of prerevolutionary Russia. They must now contain quarters for the personnel, classrooms, rooms for conducting political propaganda, a sanitary area (wash room, smoking room, drying room for shoes and uniforms, toilet), kitchen and dining area, club room, library, gymnasium, and medical station.

Before the war barracks were built according to standard specifications developed between 1938 and 1941.

After the victorious end of World War II changes took place in organizing the personnel of the army and the problems of combat training became complicated. The development of motorization and mechanization and equipping of troops with modern military technology created new problems in the field of combat, political, and special training and set up new requirements for the quartering of troops.

Modern barracks construction reflects the progress made by the Soviet building industry (high-speed assembly-line method of construction, comprehensive mechanization, industrial prefabrication techniques).

Military Camps

A military camp is a complex of buildings and installations located on a single lot and used to quarter military units, i.e., to house soldiers, NCO's, officers, and employees of the Soviet Army.

The land designated for the construction of a military camp must satisfy the following conditions. It must: (1) be dry, not subject to inundation by thawing snow, rain, or flood waters; (2) have a low level of ground water (0.5 to 0.7 m below the base of the

foundation); (3) have flat relief with a natural slope for the runoff of thawing snow and rain water; (4) have clear, readily filtering soil; (5) have full sunlight; (6) have sources of water supply and open ponds suitable for swimming.

A large camp consists of six zones: (1) barracks-drill; (2) combat materiel and tractor; (3) housekeeping; (4) storage; (5) living; (6) clubhouse and sports. The functional connection between the zones is shown in Figure 1.

The barracks-drill zone is the main one and it occupies the central location. Included here are headquarters or administration, drill buildings, barracks with areas for assembly, soldiers' (sometimes officers') kitchens and mess halls, medical station, and guardhouse. The combat materiel and tractor, housekeeping and storage zones are functionally connected with the barracks-drill zone and located as close as possible to it.

The drill fields with materiel and ground for drill exercises and training must be located in free areas beyond the built-up zone of the camp.

The soldiers' kitchen and mess halls should be near the barracks on a plot adjacent to the storage zone. It is well to have a green protective belt alongside the administrative zone.

The officers' mess hall is usually built near the clubhouse. The medical station stands on a special landscaped plot away from roads with heavy traffic.

The living zone, which is off by itself, includes houses of the quarters type, hostels, a school, kindergartens and nurseries, commissaries, and a variety of supply buildings.

The clubhouse-sports zone consists of a building together with sports areas, a stadium, garden or park.

The climate must be taken into account in constructing barracks, houses, and children's facilities.

Good interior lighting is obtained by correctly orienting the buildings to the compass points and by properly arranging the buildings in relation to one another. There should be as much unobstructed sunlight as possible. Hence, the buildings must not be set too close together. The length of shadow cast by a building depends on its height. Therefore, the space between adjacent structures should be at least one-third their height. The amount of space between the sides of buildings required to ensure adequate insulation in various climatic regions is shown in Table 1 (according to L. B. Velikovskiy). The light-climatic zones of the USSR are shown in Figure 2 (zone IV includes regions with a temperature in January of from -4° to $+4^{\circ}$ and in July $+28^{\circ}$ and higher).

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TABLE 1

Space	Climatic regions according to the plan "Fixed Position for Construction" 1952			
	I and II		III and IV	
	in the block	on the street	in the block	on the street
Between the long sides of the building	twice the height of the building	1-1/2 times the height of the building	1-1/2 times the height of the building	1-1/4 times the height of the building
Between the long sides and ends of the building	the height of the building			

Favorable and unfavorable sectors of the horizon for orientation of the windows of living quarters are shown in Figure 3 (according to L. B. Velikovskiy). In climatic zones I and II window exposure to the north, northeast (0 to 20°), and northwest (330 to 360°) is unfavorable. In zones III and IV exposure to the west, southwest (225 to 270°), and northwest (270 to 280°) is unsuitable.

Buildings with living, auxiliary, and study rooms on both sides of the longitudinal axis (if there is a middle corridor) are best constructed in zones I and II along the meridian or with a deviation therefrom of no more than 40° (Figure 4).

Buildings in zones III and IV should, insofar as possible, be laid out with the long axis along the geographic latitude with window exposure to the south and north or to the southeast and northwest. Permissible deviation from the latitudinal location should not exceed 30° (Figure 5).

A western or southwestern exposure in the southern zones is undesirable since it results in overheating during the summer.

A latitudinal exposure in zones I and II is permitted in barracks with light on two sides and living quarters for personnel all along the width of the building.

In the arctic regions and the Far East orientation to the compass points varies with the direction of the winds prevailing in the winter.

Buildings intended as hospitals should have the windows of operating and dressing rooms facing north, northwest, or northeast.

Classrooms should be laid out so as to have maximum uniformity of light throughout the day and the year. The axis of the building should run from east to west.

All this applies equally to the planning of streets. In zones I and II they should go along the meridian if the cross streets aren't too long. If the longitudinal and latitudinal streets are approximately the same length, the direction of the former may deviate 30 to 40° from the meridian; the cross streets may deviate 30 to 40° from the latitudinal direction. In southern zones it is recommended that long streets have a latitudinal orientation or deviation of about 40° to the east.

Military posts, most of which are located away from major inhabited localities, are usually well ventilated. Therefore, the builders must think not so much of providing ventilation for the streets and quarters of the post as of protecting the living quarters against strong winds, sandstorms, and snowstorms, especially in the northern and northeastern parts of the country. The buildings are best situated facing the prevailing winds. If there are snowstorms and drifts in the area, the streets are planned so that the wind blows through.

Space between residential buildings, kitchens, mess halls, and objects which pollute the air is determined by the regulations of the utilities sections. For example, irrigation fields and biological stations must be 300 m from the living zone. For filtration fields and sewage disposal the space is increased to 1,000 m. Outside toilets have to be 25 m from residential buildings; garages and parking places for cars should be 100 m away.

The built-up area should not exceed 15 to 20% of the military post; the remaining portion is to be used for roads, drill and sports fields.

Some 15 to 35% of the post grounds should be landscaped. If the free land set aside for building is covered with trees or shrubs, about one-third of the green area must be left as it is. The sports fields should be laid out on the landscaped territory next to open water (river or lake).

Barracks Planning

In planning the buildings one must take into account the hygienic requirement of providing a functional connection between the various rooms according to their purpose so as to create a flow of movement into and out of them (N. S. Kasperovich).

Figure 6 shows that after entering the barracks from the stairs or passageway one comes into the corridor-entrance hall that connects the rooms. If the corridor-entrance hall is spacious, it can accommodate a clothes tree and rifle racks. Right off the hall are the rooms of the personnel, classrooms, officers' rooms, and rooms for the cleaning of weapons, clothing, and shoes. The washroom is entered directly from the hall or through the room for cleaning shoes and clothing. It should be impossible to go through the main room of the personnel, which occupies the entire width of the building and has windows on two sides.

Company sleeping quarters should not be divided up into small rooms for convenience in directing the company and maintaining military discipline. The study and operation of various types of equipment requires a substantial number of classrooms in the barracks. Classrooms which contain bulky machinery are best set up away from the barracks near the workshops. Closets should be built there for special-purpose and work clothes.

Interior Service Regulations call for 4 m^2 of space per soldier in the area for personnel. With an average barracks height of 3.4 m this means 13.6 m^3 of air space per man. Air changed twice an hour in the sleeping quarters is fairly satisfactory. Good ventilation, especially if provided by an exhaust system, makes it possible to reduce the amount of space and size of room.

Interior Service Regulations call for every company to have its own toilet, lavatory, and room for cleaning of clothing and shoes. This group of rooms is combined into a sanitary unit. It is desirable for hygienic reasons to put company sanitary units at the ends of each story in a battalion barracks. The layout and equipment of sanitary units are shown in Figure 7.

The lavatory with a through passage should be next to the toilet. The walls should be painted up to 1.6 m. Regulations call for one faucet for each 5 to 7 soldiers 70 cm apart.

Every lavatory must have foot baths in the form of concrete troughs with hot and cold water. The baths are arranged at the rate of one place per 30 men. The places are separated by low partitions 85 cm apart. Showers occupying 1 m^2 of space can be conveniently combined with the foot baths.

Flush toilets are planned at the rate of one for 12 to 15 men. The places are separated by low partitions 90 cm apart. Urinals are best constructed in the form of troughs in the floor and the walls tiled to a height of 1.2 m. Calculation of the trough: one running meter for 25 to 30 men. If urinals are to be used instead of troughs, the rate is one for 12 to 15 men.

The sanitary unit is to be entered through the lavatory or cleaning room. The sanitary unit may not be entered from the stairs since the putrid air would come through them to the upper floors.

The room for cleaning clothing and shoes, which is also used as a smoking room, contains benches for cleaning shoes, a small closet to store odds and ends, and a can for cigarette butts.

Driers are installed at the rate of one for 80% of the personnel for puttees, boots, and sometimes street clothes.

Each drier has a drying chamber, fan, and heater. Some driers operate continuously, being heated by stoves of moderate heat capacity with brick gas flues and fire tubes; other driers operate periodically, being heated by stoves of large capacity.

Puttees are dried at a room temperature of 50 to 55°. When the drying room is used for boots, overcoats, and fur objects the temperature is lowered to 45°. Two corner thermometers are provided to control the air temperature. Heat must be applied in such a way that the air in the exhaust pipe is not below 40°.

The doctor (feldsher) is responsible for checking on the effectiveness of ventilation of the drier. Puttees and other articles of clothing must be dried in a current of warm air.

The design for a two-story stone barracks executed by Prof. N. S. Kasperovich is an example of the interior planning and equipment of a modern barracks (Figure 8).

The first floor of the barracks is planned to provide sleeping accommodations for 50 men, battalion orderly room, classroom, room for cleaning weapons, general area for cleaning shoes, lavatory, and smoking room with drying closets, shower room, and toilet. The second floor has more or less the same layout as the first floor. Useful floor space per man 7.7 to 7.0 m^2; cubic content of building 3,760 m^3; volume per man 34.8 to 31.3 m^3.

Lighting

Extensive research since the time of F. F. Erisman has shown that good natural light increases efficiency, raises the productivity of labor, favorably affects the mood and sense of well-being of people with resultant cheerfulness and joie de vivre. In the northern latitudes the importance of direct sunlight in rooms where people have to stay for a long time is particularly great.

Adequate lighting and insulation of living and study quarters can be ensured by properly orientating the building to the compass points, allowing for the standard amount of space between buildings, and choosing the appropriate size, form, and location of light openings.

In barracks planning the coefficient of depth of slope is determined from the formula suggested by the light engineering commission of the Academy of Sciences USSR:

$$L = \frac{V}{N},$$

where B is the distance from the exterior surface to the farthest point from the windows; N is the height from the upper edge of the window to the floor; L is the coefficient of depth of slope. This coefficient is 2.5 in sleeping quarters.

Light from one side is permitted for living, study, auxiliary, and other comparatively small rooms. Light from two sides is required in large rooms: sleeping rooms, dining rooms, halls, foyer of clubrooms, and sports rooms.

The area of light openings for most buildings in a military camp is determined geometrically, although this calculation does not give a true idea of the degree of illumination of the rooms. In sleeping

quarters the ratio of window area to floor space (the light coefficient) must be 1:8 for the central latitudes and 1:10 for the regions south of 50° and north of 60°. The ratio must be more than 1:6 or 1:7 in study rooms, classrooms, headquarters, kitchens, and mess halls. Lighting must be maximal -- 1:3 and 1:5 -- in operating and dressing rooms and 1:6 and 1:5 (depending on the latitude) in wards and doctor's examination rooms.

When geometric standards of natural light are used, no account is taken of the light and climatic features of the location of the barracks nor the orientation of the windows to the compass points, the shade cast by the buildings standing opposite, trees, architectural and decorative elements of the building (balconies, pilasters, or columns). Reflected light is likewise ignored even though it may be three or four times as much as direct light on the side opposite the windows. Finally, with geometrical calculation it is impossible to allow for the depth of the room, shape and location of the windows.

Professor N. M. Gusev worked out a method of rating natural light for schools that makes it possible to calculate the area of glass surface of windows according to room area and other factors. This method of rating is useful in determining the natural light of living and study quarters in barracks from actual measurement and from plans. This last is particularly important for military hygienists who are responsible for precautionary inspection of the planning and construction of barracks as far as sanitary matters are concerned.

In 1951 V. B. Veynberg proposed a method of calculating the natural light for residential buildings that may also be used in major army construction projects. According to this calculation, the lighting of a room is satisfactory if the amount of light is equal to or greater than that obtained from the formula

$$S = K_1K_2,$$

where S is the required ratio of window area to floor space; K_1 is the coefficient characterizing the purpose of the room and the light conditions of the locality; K_2 is the coefficient which takes into account the shading of the windows and relative brightness of the visible portion of the sky, i.e., the exposure of the windows of the room.

The formula $S = K_1K_2$ for the value of S is justified in cases where the depth of the slope does not exceed 2 (S. I. Vetoshkin).

The values of the coefficient K_1 for the three light-climatic zones are shown in Table 2.

TABLE 2

Light-climatic zones	I	II	III
Kind of room	Coefficients		
Living rooms, sleeping quarters, classrooms, kitchens, mess halls	0.16	0.13	0.10
Halls, corridors, stairs	0.09	0.07	0.06

The values of the coefficient K_1 shown in Table 2 correspond to the southern exposure of the windows in the absence of shade by buildings or trees standing opposite. It is assumed that the windows have double frames and a large amount of glass.

The coefficient K_2 serves as a correction for window orientation to the other compass points and takes into account the shade cast by buildings standing opposite. The values of the coefficient K_2 are shown in Table 3.

TABLE 3

Window exposure	Tangent of the angle of shading $\frac{H}{V}$					
	0.0	0.2	0.4	0.6	0.8	1.0
South, southeast, and southwest	1.0	1.2	1.6	2.0	2.4	2.8
East and west	1.3	1.5	1.9	2.3	2.7	3.1
North, northeast, and northwest	1.6	1.8	2.2	2.6	3.0	3.4

If the glass in the windows measures less than 0.3 m^2, the value of S is multiplied by 1.2; if there is a single pane the value of S is multiplied by 0.7.

If the windows are shaded by architectural details, the value of S is multiplied by a correction factor according to Table 4.

TABLE 4

Angle α of shading of windows, in degrees	10	20	30	40	50	60	70	80
Shading by building features		Correction factors						
Columns, pilasters	Not taken into account	1.1	1.2	1.3	Not permitted			
Overhangs, loggias			1.1	1.1	1.2			
Windows near re-entrant angles of the building			1.1	1.1	1.2	1.2	1.3	1.3

The angle (α) of shading of windows is determined from the diagram in Figure 9.

To determine the window area in a living room 18 m^2 on the second floor with windows facing northeast at 40 m opposite a four-floor house 16 m high, the value of the coefficient K_1 has to be found in Table 2. It will be 0.13 for light-climatic zone II.

The value of the coefficient K_2 is found by computing the tangent of the angle of shading of windows.

Allowing for a store 6 m high planned for the first floor of the building, we find that H = 10 m since the cornice of the building opposite is 10 m higher than the middle of the window (16 - 6 = 10 m).

The tangent of the angle of shading is determined from the equation

$$\frac{H}{V} = \frac{10}{40} = 0.25.$$

Table 3 gives the values of the coefficients for the tangents 0.2 and 0.4. For the northeast with 0.25 the tangent of the angle of shading, the value of K_2 will be 1.9.

Substituting in the formula the values of the coefficients K_1 and K_2 found, we obtain the following light ratio:

$$S = K_1K_2 = 0.13 \cdot 1.9 = 0.24.$$

It follows from this that the window area in this case must be 18·0.24 = 4.32 m^2. This amount of light can be produced by two windows.

The natural light of a given point on the earth depends on many things: elevation of the sun above the horizon, cloudiness, dustiness of the air, magnitude of reflection of light by the snow, grass, etc. The variability of these conditions is responsible for the substantial fluctuations in light both throughout the year and during a single day.

This variability in natural light made it necessary to adopt as a unit of measurement an arbitrary value called the coefficient of natural light CNL (ratio of the light of a given point in a room to the external light of points out of doors at the same time). Light inside a room is always less than the light of an open place. Consequently, the CNL shows how much less the light of a given point is than the light of an open space. The CNL is usually expressed as a percentage according to the equation

$$e = \frac{E}{E_0} \cdot 100; \; E = E_0 \cdot e\%.$$

The light of a given point in an enclosed place is equal to the external light (horizontal surface) multiplied by the CNL.

The All-Union State Standard 5291-48 and the plan "Fixed Position," 1952 call for the value of the CNL to be fixed at the most distant points from the windows in rooms illuminated by side light (windows) (Table 5).

TABLE 5

Category	Type of rooms	Value of CNL, %
I	Operating, drafting	2
II	Dressing, class, laboratories, reading rooms, work places of kitchens and mess halls	1.5
III	Wards, doctors' examination rooms, auditorium	1.0
IV	Sleeping quarters in barracks, passageways in mess halls, gymnasiums	0.5
V	Sanitary units, smoking rooms, corridors, entrance halls	0.25

It is much easier to solve the problem of artificial lighting of barracks rooms, which have the following hygienic requirements:

(1) Sufficient light for work areas and the rooms in general;

(2) Fairly uniform lighting of work surfaces and within the work place (a disproportion of no more than 1:2 is permitted);

(3) Absence of a great difference in brightness of work surfaces and surrounding background;

(4) Limiting the blinding effect of the source of light (the brightest part of the lamp must not exceed 0.5 sb);

(5) Elimination of reflected brilliance of work surfaces by using flat paint.

In designing artificial lighting one can be roughly guided by the standards of light in lux shown in Table 6.

TABLE 6

Type of rooms and work surfaces	Light standards, lux: on work places	Light standards, lux: in rooms
Barracks		
Staff rooms (work tables)	300	100
Rooms for political education and classes	150	75
Mess halls and snack bars	150	75
Lavatories and shower rooms	150	100
Toilets	--	50
Medical facilities		
Operating room for major surgery	3,000	100
Operating room for minor surgery	2,000	100
Dressing, pre-operational, examination rooms	500	100

The amount of light -- overall and on work places -- can be evaluated from photometric data. However, army doctors do not have ready access to light meters so they have to resort to the simpler but less precise rating method of determining the amount of light.

Ventilation

F. F. Erisman pointed out 65 years ago that clean air is a prime sanitary and esthetic need of man. Good air in barracks rooms is a prerequisite for health. Numerous studies of air in barracks made by Soviets (V. Stolyarov, I. G. Dashkevich, N. Kleptsov, I. Alekseyev and P. Tikhonirov, I. F. Aleksandrov, and others) and foreign investigators correlate the sick rate of soldiers (especially droplet infections) with poor quality of air in sleeping quarters.

A 1924 medical report on the English army cited instructive data on the angina rate in the old, shabby barracks and the new, better built barracks of Edinburg. The sick rate of the latter was five times lower than that of the former in December, three times lower in January, and eleven times lower in March.

Recognition of the special role of air in the spread of influenza and other infections is important in determining the preventive measures to be used, the most valuable being efficient ventilation of living, study, and work rooms.

There are two types of ventilation: natural and artificial. In the former air is exchanged by a difference in temperatures. The wind is a major factor here. On the windward side pressure forces air into the rooms through the pores of the building material and cracks in the windows and doors.

Air exchange in rooms is assured by an exhaust fan usually with a heat booster. This circulates the air approximately once an hour without an organized feed.

A central heating radiator set up in the attic may be used as a draft stimulator.

The barracks are ventilated by drawing heated air from the upper part of the sleeping quarters or classrooms through vents and ducts in the walls (not the outside walls).

When the amount of air exchanged is small (the contents of the room changed once an hour), the air seeps in and is removed through the exhaust ducts operating on the principle of a gravitation system without mechanical stimulation. Efficiency of the system is enhanced by the use of deflectors installed in the upper part of the exhaust shaft 0.5 to 1.0 m above the gable of the roof (L. B. Velikovskiy).

More efficient ventilation is provided by a mechanical booster, which is used when air circulation has to be intensified. This type of ventilation is installed in auditoriums, lecture halls, kitchens, mess halls, and hospitals. Air seeping in is not enough and outside air must be artificially brought in with due regard for hygienic requirements.

Figure 10 shows the way that air moves and the direction of air currents in various types of rooms. On the windward side the wind rarefies the air and helps it to seep through the walls. The passage of air through doors and windows plays a leading role in natural circulation; infiltration through the pores is not particularly significant.

In cold weather the air inside a room is always warmer than the outside air. Consequently, the specific weight of the outside air is invariably higher than the volumetric weight of the inside air. The difference in pressure between the inside and outside of a building causes the air to move through the pores.

Theoretical calculations have shown that at certain temperatures and when the outside air is still, pressure in the lower part of the room is directed within while in the upper part it is directed without. This means that the colder and, therefore, the heavier air penetrates from without, whereas the warmer or lighter air tries to get out. There is a neutral zone in the middle, which may be at different heights depending on where there are more openings in the walls -- above or below.

The neutral zone can be shifted up or down to increase air circulation in kitchens, mess halls, smoking rooms, and toilets. Accordingly, exhaust vents are placed in the walls to help to raise the neutral zone and movement of air upwards.

Air is circulated by artificial ventilation using mechanical or heat boosters to create a difference in pressure. Technically, four different kinds of ventilation may be distinguished. (1) inflow, (2) exhaust, (3) inflow-exhaust, and (4) recirculation (movement of air in an enclosed place without renewal or with partial renewal).

Steam, tobacco smoke, and odors of gaseous products from kitchens, smoking rooms, and driers are eliminated by powerful ventilators that draw out the air and bring other air in from the adjoining rooms.

Inflow-exhaust ventilation to supply heated and purified air and to eliminate foul air is installed in buildings intended for cultural activities, kitchens, mess halls, and hospitals. The quality of the air is determined by the place of intake and system of purification.

The intake pipe must be on the outside of a building as far as possible from sources of air pollution. Purification and heating of the air supplied to rooms is effected by means of filters and heaters in the cellar. Exhaust chambers are usually placed in the attic. Ventilation ducts are always installed in the interior walls of a building to avoid cooling and interference with the draft.

Hygienic requirements for heating and ventilation in living quarters, classrooms, mess halls and kitchens, hospitals, clubhouses, baths, and laundries are as follows:

TABLE 7

Type of room	Inside temperature, °C	Ventilation exchange: inflow	Ventilation exchange: exhaust
1. Barracks and officers' housing			
Sleeping quarters and corridors	16 - 18	--	1
Classrooms and places for political education	16 - 18	--	1
Lavatories	16 - 18	--	1
Rooms for cleaning	16	--	3
Toilets	18	--	*
2. Hospitals			
Wards	20	**	**
Operating room	25	6	5
Dressingroom	22	2	2.5
3. Clubs			
Auditorium	16	***	***
Smoking room	15	--	10
4. Kitchens and mess halls			
Dining hall	16	5	4
Pantry	16	1.5	2
Boiling room	5	****	****
Dishwashing room	18	4	5
Place to keep bones and garbage	5	--	10

Footnotes to Table 7:

*Exhaust in barracks toilets must be planned at the rate of 50 m^3 an hour per hole

**Exhaust and inflow in wards are planned at the rate of 10 m^3 an hour per man

***Exhaust and inflow in an auditorium are planned at the rate of 20 m^3 an hour per man

****Estimated

Disinfecting the Air in Barracks

The main source of pathogenic microflora is man (especially his respiratory tract). Sneezing and coughing cause the formation of a bacterial aerosol consisting of drops of various sizes (from 2 to 100 μ and more). The fine-drop phase (from 3 to 5 μ) has complex electrochemical relations with air and is a stable colloidal system. Air containing large bacterial drops is an unstable system like a mechanical suspension.

Bacterial dust forms as a result of the drying of bacterial droplets. It is important to note that the droplets decrease in size with evaporation of the fluid and the speed with which they settle decreases rapidly. As the drops become smaller, the rate of evaporation increases and drop nucleoli instead of droplets remain in the air. The dust phase of a bacterial aerosol is also of great epidemiological significance if it consists of microorganisms that do not lose their viability with drying.

S. I. Kudryatsev's observations show that bacterial contamination of the air in classrooms increases as people come in; it drops somewhat during the lessons but rises again at the end. Bacterial contamination of the air in sleeping quarters over a 24-hour period is shown in Figure 12.

Ventilation is the most effective way of controlling bacterial contamination of the air in closed places. P. A. Vavilin's research has shown that 15 minutes of ventilation in barracks reduces the number of microorganisms in the air by 80%. A good method is constant inflow-exhaust ventilation. The fact that it is very effective at any phase of the bacterial aerosol has practical significance. Incidentally, the multiphasic structure of the aerosol complicates the use of physical and chemical disinfectants.

Another important method of combating aerogenic infections is the energetic control of dust. Accordingly, besides regular and careful ventilation and thorough cleaning of the floor and equipment, successful use has been made in recent years of dust-collecting substances. Treating wood, parquet, and other floors with these substances is a simple matter. A double application about three to five times a month reduces the amount of dust and bacterial contamination of the air (P. A. Vavilin).

Barracks floors can be treated with paraffin and spindle oil, emulsol, or solar oil with a little kerosene added as a thinner. Red lead may be added to the paraffin or spindle oil to stain the floors reddish brown. The floors should first be carefully washed with boiling water containing caustic soda. Some 1.5 to 2 liters of oil per 100 m^2 of floor are applied uniformly over the entire area. Emulsol, which is used to cool the blades of metal-cutting tools, is mixed to form a 30% solution and applied at the rate of 3 liters per 100 m^2 of floor. The washed floors are dried with rags dipped in the emulsol solution and the excess oil wiped off with other rags.

An investigation for 17 weeks in an American installation (Fort Bragg) showed that treating floors with oil decreased the incidence of upper respiratory tract infections among the soldiers 30 to 40%; during epidemics the rate dropped 6 to 12%, although the number of microorganisms in the air of the experimental barracks dropped 75 to 90% as compared with the controls.

A great many microorganisms, including hemolytic streptococci, are thrown into the air when beds are made and the floors dry swept. These streptococci, it has been repeatedly proven, remain viable for many months in linens, clothing, and bed accessories.

The danger of spreading infections through bed linen can be overcome by treating it with a 3 to 5% oil emulsion added to water.

G. Bartley tested sanitizing measures in barracks. He observed three companies of 200 men each. In company 1 an oil emulsion was used to treat the linens, blankets, and handkerchiefs. In company 3 disinfectants (triethyleneglycol, etc.) were sprayed about when the beds and floors were tidied up. Company 2 served as a control. The best results were shown by company 1 where the number of streptococci dropped 80%; in company 3, it dropped 60%. In company 2, 61 cases of infections of the upper respiratory tract were reported; there were 40 and 67 cases in companies 1 and 3, respectively.

Bactericidal ultraviolet lamps (BUV) have been used in recent years to disinfect the air in bacteriological and virological laboratories, blood transfusion centers, operating and dressing rooms, in the food industry and trading network.

Ya. E. Neyshtadt designed a recirculating device in the form of a piece of metal tubing with covered bactericidal lamps to irradiate the air when people are present. Air is drawn through this tube from the room occupied by people. The lamps are of the BUV-30-P type (127 v) with one lamp for 8 to 10 m^3 of room volume.

The installation of bactericidal lamps in the ceiling protected from below by metal shields (reflectors) is less effective.

Unshielded lamps may be used in rooms when there are no people at the rate of one BUV-30-P (127 v) per 12 to 15 m^3 of air volume.

Bactericidal lamps are most effective when the air temperature ranges from 18 to 25° and the relative humidity is not in excess of 65 to 75%. At lower temperatures they do not work too well and at +5° they do not ignite. At 30 to 35° overheating of the starter is possible (Ya. E. Neyshtadt).

According to S. I. Kudryavtsev, five hours of irradiation
(daily) of barracks sleeping quarters by bactericidal lamps reduces
the amount of microflora 49 to 62%. The number of hemolytic
staphylococci and streptococci dropped 85 to 92% after 60 minutes.
Diseases of the respiratory tract in the experimental group
were 11.4% lower than in the control. During an outbreak of influenza
the sick rate in the experimental group turned out to be 19% lower
than in the control.
The most useful preparations for chemical disinfection of the
air in barracks are aerosols of hypochlorites, diphenols, and glycols,
which are effective in concentrations that are safe for man.
Extensive experiments in the American army to control diseases
of the upper respiratory tract indicate that glycolization of the
air combined with treating the floors and bed linen is more effective
than oiling the floors. The latter measure reduces the incidence of
bacterial infections but has no effect on diseases of viral etiology.
Evaporation of lactic acid (1 g per 200 m^3) gives good results.
Lactic acid has an effect on the dust and bacterial phases of a bacterial
aerosol.
These new methods of disinfecting the air are somewhat helpful in
combatting droplet infections, but they cannot be regarded as the chief
means of preventing influenza and other air-borne diseases. Proper
planning of living and study rooms in barracks, correct spacing of
beds, and, above all, control of dust and good ventilation — these
are the best preventive measures.

Heating

Interior Service Regulations require a steady air temperature of
16 to 18° in living quarters, 16° in kitchens, 15° in gymnasiums.
The optimum temperature inside living quarters is determined
by the general climatic conditions. In a cold zone it must be 21°,
in a moderately cold zone about 20°, in a moderate or warm zone from
18 to 19°, and in a hot zone from 17 to 18°.
Temperature variations in personnel quarters may not be greater
than 3° in 24 hours. Changes in horizontal readings of the thermometer must not exceed 2°, vertical readings 2 to 2.5°, per meter of
altitude. The temperature of the outside walls must not differ from
the inside temperature by more than 3°. This requirement is important
in the light of the modern theory of the role of radiation in heat
exchange of the organism.
An essential requirement of heating equipment is that it not
pollute the air in rooms with the products of incomplete combustion of
the fuel (especially carbon monoxide) or the products of volatilization
of organic substances.

CHAPTER II

CAMP HYGIENE

There are two types of camps differing in purpose and length of time the soldiers remain there -- training and field. Training camps are built in advance and for a long time, being more or less permanent. They are divided into summer and winter camps according to their facilities. Field camps are set up to provide for the temporary rest -- day or night -- of troops on a march or for rest during wartime.

In the case of a summer encampment the troops are usually housed in tents; huts, dugouts, or heated tents are used in the winter.

The camp routine is arranged so that the training conditions simulate the situation in wartime.

The forms and methods of hygienic protection of the troops vary with the type of training.

The medical service is responsible for: (1) preliminary sanitary investigation of the camp site and installations (tent beds, kitchen, mess hall, ration supply dumps, water supply, toilets, etc.); (2) elaboration of appropriate hygienic measures on the basis of the sanitary investigation; (3) chemical and bacteriological analysis of the sources of water to ascertain what has to be done to purify and disinfect the water; (4) investigation of portions of the camp site that might be dangerous with respect to malaria; (5) study of the epidemiological factors in the area of the camp site (with special attention paid to intestinal infections, tularemia, leptospirosis, and infectious hepatitis); (6) establishment of close contact with local public health agencies to obtain timely information and coordinate hygienic and antiepidemic measures among the troops and civilian population.

Special medical steps are taken before the soldiers enter a camp: medical checkup of the personnel, detection of those with malaria, and preventive inoculations.

While the troops are in camp considerable attention is paid to ensuring hygienic protection during exercises in the field, marches, physical training, and the maneuvers that complete the summer encampment.

To determine the effect of the camp period of training on the health, physical condition, and endurance of the soldiers before going to camp and after the fall maneuvers are over, anthropometric measurements are taken and functional tests given (measurement of growth, determination of body weight, dynamometry, tests of strength and endurance, functional tests of the cardiovascular system, investigation of the vital capacity of the lungs, etc.).

Hygienic Requirements for a Camp Site

A camp site is selected in consultation with a representative of the medical service who is responsible for making a hygienic appraisal of the site and the adjacent area.

The water supply is the first thing to be considered. The representative of the medical service together with the engineers check on the local water resources. He is responsible for evaluating the quality of the water and determining its potability, suitability for housekeeping and technical purposes.

The topography of the site and properties of the soil have major hygienic significance. The surface must be level with slight slopes for the runoff of rain and thaw water. The living quarters should be erected on sandy clay or sandy loam soil with good drainage. Clay and sand soils are not suitable, the former because of impenetrability by water, the latter because of the dust, which is undesirable equally for the personnel and for the materiel.

The camp should be located about 2 km from swampy sections -- an important measure for the prevention of malaria.

Elevated, dry places not likely to be inundated during floods are set aside for the tents, huts, medical buildings, and sports fields. These places must be located at a considerable distance from the fields used for sewage disposal, filtration and irrigation, repair shops, and garages.

In planning the camp the direction of the prevailing winds must be taken into account. Accordingly, data are collected during the sanitary investigation of the camp site to construct a "wind rose."

The camp area is divided into rectangular blocks with longitudinal and latitudinal lines that also serve as lines of communication. It is divided into strips by three lines parallel to the front of the camp: forward, center, and rear. The distance between the lines is determined by the system of arranging the tents, necessary buildings and facilities. The camp is divided perpendicular to the front by cross lines laid between battalion and special regimental units.

The portion of the camp bounded by the cross lines receives the name of the battalion or unit situated in the first strip.

In the first strip between the forward and center lines are the tents or huts of the personnel of the regimental units in numerical or combat order. The second strip between the center and rear lines includes headquarters, the medical station, kitchen, and mess hall. The toilets, stables, garages, depots, forges, shops, and other service buildings are located in the third strip between the rear line and the back road (Figure 13).

Niches are placed behind the company's tents and wash stands installed. In back of them are set racks for the weapons and tables on which to clean them.

Battalion gym areas and fields for athletic contests are generally laid out in front of the forward line opposite the center of the battalion disposition. The regimental clubhouse should be located in a part of the camp where an open stage can be built with seats for spectators in front and with club pavilions.

Deviations from this layout are permitted to suit local conditions.

The front of the camp need not be laid out in a straight line, but it may follow the terrain (e.g., a river or lake). The space between units may be increased or decreased.

Heavy Tents and Huts

During the period of camp training the privates and NCO's are mostly quartered in tents erected on special foundations. The Soviet Army uses three kinds of foundation: a wooden foundation with sloping sides, a wooden foundation with vertical sides and sloping poles, and an earthern foundation with wooden rollers. The base of the foundation is raised 10 to 15 cm above the ground to protect the tent from water flowing underneath. Plank beds to accommodate 10 men are placed 40 to 50 cm above the floor.

The army most commonly uses wooden foundations with sloping sides (Figure 14) except where the tent panel folds at the place where it meets the foundation. Earthen sides have proven to be unhygienic and are scarcely used any more. Whenever possible, the sides should be somewhat raised to prevent the tent panel, which may be soaked by the rain, from touching the pillows.

To provide for ventilation, Interior Service Regulations specify that the tents are to be set up in rows (2.5 m) with spaces between rows (5 m) and the floors raised. If the camp is located in a woods, the space between tents may be varied to avoid cutting down any trees.

Huts have some hygienic advantages over tents. They are roomier and furnish better protection against the weather.

Antimalarial Measures

Control of malaria-carrying mosquitoes is a major element in protecting the health of troops in camp. Antimalarial measures include the draining of swamps and ponds that have no economic or military training value. All other bodies of water must be treated so as to prevent development of the larvae of the mosquitoes.

Another important measure is destruction of the larvae in their breeding places and control of the winged mosquito. Thus, throughout the entire period of encampment the open bodies of water are treated with larvicides. A variety of insecticides are now used to destroy the winged mosquitoes. Eradicating the larvae in anopheles-infested water must be done not only in the camp area but also within a radius

of 5 km from the camp. Small bodies of water containing larvae are best oiled every 12 to 15 days. Larger bodies should be dusted with Paris green. Big rivers and lakes are dusted from planes.

Some 10 to [illegible] g of oil are needed for each m^2 of water surface; kerosene may be used at the rate of 20 to 40 g/m^2 (best mixed with sawdust). Hexachlorane in the form of [illegible] or a solution in kerosene has recently come into use. Each hectare of water surface requires 100 g of the pure preparation.

Paris green is mixed with talc, dirt, or slaked lime in the proportion of 1:[illegible]. 0.8 to 1.2 kg of the preparation is required to treat 1 ha of water.

Good results may be obtained from using Paris green in the form of a suspension with kerosene at the following rate for 1 ha: 1 kg of Paris green, 2 to 2.5 liters of kerosene, 600 g of potash soap and 250 liters of water.

The following may also be used to eradicate larvae: calcium arsenite in a 1:20 mixture at the rate of 1 to 1.6 kg/ha; arsenal (?) 1.5 to 2 kg/ha in the proportion of 1:19; thiodiphenylamine at the rate of 1 to 1.5 kg/ha in a 1:19 mixture.

The larvicides must be handled with care due to their toxicity. Residues of the chemicals after the apparatus is loaded must be buried in the ground or burned. Cattle are not permitted to drink the treated water for two or three days afterward. Liquid larvicides toxic to fish may not be used. Most of the larvicides (except the liquid ones) are toxic to bees so the hives must be moved elsewhere while the ponds are being treated.

However, these radical but time-consuming measures cannot always be taken in a camp. When this is the case, it is mandatory to use contact insecticides to eradicate the mosquitoes. Experience in using DDT and hexachlorane in malarial locations favors simultaneous and uniform application of these preparations to all places that attract mosquitoes. Treatment of all tents, huts, depots, etc., is the principal method of exterminating mosquitoes in camps with a great many infested bodies of water.

DDT in the following proportions is to be used on wood and brick surfaces: (1) 10% aqueous suspension of 10% DDT dust at the rate of 0.5 to 1 g/m^2 (100 ml/ ^{2} of suspension); (2) 1% emulsion of DDT concentrate or paste at the rate of 0.5 to 1 g/m^2 (30 to 100 ml/m^2 of emulsion). According to P. Nikitin, 10% DDT dust is sometimes used on the places where the mosquitoes stay during the day.

The interior surfaces of kitchens, dining halls, and huts are treated with DDT at least twice while the troops are in camp. Effectiveness of the preparation is checked by wiping the wall with a piece of paper, which is then placed in a test tube with flies. The development of characteristic paresis of the insects' extremities 20 minutes later is proof of potency of the DDT on the surface treated. DDT crystals may be detected on a wall with a magnifying glass.

Heavy tents are treated in the same way at the rate of 1.5 to 2 g/m^2 of pure preparation.

To control blood-sucking insects, Ye. N. Pavlovskiy recommends attachment to the tent panels of netting treated with one of the following mixtures: (1) lysol 15%, turpentine 3%, and water 77%; (2) t[illegible] 10 and [illegible], caustic alkali 90%; (3) creolin 10% and water 90%. One need do no more than spray the edges of the panels with a hydraulic hose, as shown in Figure 15.

Tents are treated both inside and outside. The cloth must first be rid of dust, leaves, and pine needles. The flooring as well as the ground underneath also has to be treated. In any weather it is advisable to sprinkle the vegetation surrounding the tents.

The netting on windows and Pavlovskiy "curtains"* have to be sprinkled with the insecticides. In addition, strips of the "curtains" are impregnated with a solution of tar in 5% caustic alkali (KOH) or a 15% solution of lysol (naphthalysol). This impregnation repels mosquitoes. (*Pavlovskiy's "curtains" are made from long strips of cloth 10 to 12 cm wide; they serve to keep out mosquitoes, flies, etc.)

According to F. T. Morovin and B. N. Nikolayev, sprinkling the walls and floors with a suspension of dusts is less effective than treatment with other preparations of DDT and hexachlorane. Still less effective is the inclusion of DDT and hexachlorane in whitewashing material.

Well impregnated surfaces remain toxic to mosquitoes and other insects (flies) for six weeks in the south and for five months in the north. F. T. Morovin and B. N. Nikolayev recommend the use of DDT and hexachlorane alternately for repeated treatments. It should be remembered that surfaces painted with oil paint do not hold an insecticide suspension or emulsion very well. Hence, more concentrated solutions must be used.

Mosquito Control

Mosquitoes attracted to human dwellings may be controlled by DDT, hexachlorane, and pyrethrum in the form of dusts, emulsions, suspensions, and aerosols. Living quarters and service buildings, as well as nearby shrubbery, are treated with these preparations. DDT is employed inside the rooms; the outer walls and non-living quarters may be treated with hexachlorane. One square meter of surface requires from 1 to 2 g of pure DDT or hexachlorane. Areas thus treated retain their insecticidal action for 1.5 months (V. I. V[illegible]).

Mosquitoes in closed places may be exterminated by aerosols produced by vaporizing DDT or hexachlorane at 150 to 180°. Insecticidal aerosols may also be obtained by burning bits of paper impregnated with DDT at the rate of 120 to 200 mg/m^3 of pure substance. The

mosquitoes die within 30 minutes (total paralysis sets in). Hexachlorane aerosols are not suitable for living quarters, kitchens, and mess halls.

Ye. N. Pavlovskiy recommends the treatment of tents with repellents when the troops are in camp. Individual protection from mosquitoes is afforded by Pavlovskiy netting impregnated with repellents.

The windows of camp huts, hospitals, and other types of closed structures are protected by metal screens (0.75 mm^2) or starched gauze ironed on with a hot iron.

A paste of anise and eucalyptus oils with turpentine -- three drops of each ingredient per 30 g of lanolin -- is an effective repellent. Dimethylphthalate is a good protection against mosquito bites.

Tick Control

Some species of ticks native to the USSR are transmitters of such dangerous infections as taiga encephalitis, Crimean hemorrhagic fever, tularemia, and relapsing fever.

Ticks are most active during the spring and summer months; toward fall most of them undergo a series of transformations.

Protection against ticks when in the taiga is provided by ordinary overalls with double clasps and elastic sewn into the sleeves. The back of the head, ears, and chin are protected by overalls equipped with hoods.

If no overalls are available, an army uniform can be used. The collar of the field shirt is carefully adjusted while the sleeves are tightly tied together. The shirt is tucked into the trousers drawn close by a belt. Sharovary [wide trousers] and breeches are tied at the ankles. Boots may be worn only with leggings.

A handkerchief is tied around the head to protect the hair, ears, and neck. One long end is secured to the raised collar of the shirt, the other long end covers the face. Both ends are knotted under the chin.

The soldiers must examine each other at least twice a day, paying special attention to the folds of the uniform, pockets, and seams. The inguinal folds, helix, and hairy portions of the skin must be very carefully inspected. Any ticks found are burned or dropped into boiling water, a 10% solution of lysol, or a 2% solution of phenol, kerosene, or tar.

Ticks clinging to the body are removed with the fingers or tweezers. If a part of the proboscis remains in the skin, it is taken out with a sterile needle and the place of the bite is wiped with alcohol and seared with iodine or silver nitrate.

Ye. N. Pavlovskiy has suggested the use of netting impregnated with: (1) a 15 to 20% emulsion of creolin and water; (2) a 5 to 10% emulsion consisting of a mixture of 1 part tetrachlorophenol, 1 part

trioxydiphenol, and 2 parts "Petrov's contact"* (the ingredients are mixed at 60°). The use of dimethylphthalate gives even better results. (*"Petrov's contact" is obtained by treating petroleum with fuming sulfuric acid; it contains 40 to 50% sulfo acids; it is used as a disinfectant and emulsifier.)

When spending the night in the taiga, the bedding (poncho, canvas) are saturated with a repellent (a 10% solution of lysol or naphthalysol).

The exposed skin is protected against the bites of black-legged ticks by an ointment consisting of at least 1% of preparation K, camphor or thymol. Potency is retained for two or three hours (V. I. Vasilkov).

V. A. Nabokov and R. G. Dergun' have suggested sewing onto outer garments cloth strips impregnated with creolin, naphthalysol, SK emulsion, lysol, or white ichthyol paste. The strips remain potent from three (white ichthyol paste) to eight days (creolin).

Dimethylphthalate is the best repellent. This preparation is especially valuable because it provides protection against both ticks and other blood-sucking insects — mosquitoes, gnats, and lice.

According to V. A. Nabokov, a person working in woods with low herbage can be safely protected against ticks by treating the sharovary with dimethylphthalate from the upper part of the shoes to the pockets. The entire outfit is treated with dimethylphthalate when the soldier is in woods with high herbage. The cloth does not need to be saturated with the preparation; it is sufficient to rub the fabric with a piece of felt dipped in dimethylphthalate. The outer garments should be treated every five to seven days. Treatment of a complete outfit requires 250 g of the preparation, the sharovary 150 g.

CHAPTER III

TROOP HYGIENE IN THE FIELD

In a war of movement combat activity involves frequent shifts of route formation (marches, motor transport). Major and minor halts are provided on marches so that the officers and men can rest and regain their strength; night halts and day's rests are intended for prolonged rest. Under battle conditions troops often have to be pulled back to the rear for rest and replacements.

In peace time troops take up positions for night halts and rest during marches, on fall maneuvers, and field exercises. Sound, efficient organization is in all these cases a major prerequisite for rest and restoration of energy.

The experience of World War II has shown that troops may take up positions for rest, depending on the time of year, weather, and combat situation, (a) in inhabited localities, (b) outside of inhabited localities, i.e., in the field, bivouac, and (c) in a combination of both, i.e., some of them in an inhabited locality, and some in a bivouac (billets and bivouac). Troops are afforded better facilities for rest in the winter in inhabited localities. If there are none or the living quarters and public buildings are unsanitary or there are epidemic indications (the presence of people with infectious diseases), the troops bivouac. If quarters are insufficient, the troops stay in camps. The latter is always preferred in the summer. All places chosen for rest must have water and fuel.

To ensure the proper organization of rest at a night halt, quartering parties are sent out from each unit and subdivision to: (1) inspect the site from the sanitary point of view, (2) assign quarters or bivouac areas to the subdivisions of the unit, (3) designate the places for the personnel and medical installations. The quartering parties include a physician or feldsher depending on the circumstances and sanitary indications.

Troops should not occupy inhabited localities where there is a substantial amount of infectious diseases. If the number of infected people is small, their homes are marked so as to indicate that they are not to be used.

Medical installations and headquarters may be set up in residential buildings if there is a shortage of rooms. Some rooms must be set aside for combat units to enable the men to take turns getting warm.

Places for disposition of troops in the field are selected by headquarters on the basis of information obtained by sanitary reconnaissance.

Field Shelters

Various structures are used to shelter troops outside of inhabited localities: tents, screens, huts, and dugouts. The type of structure and equipment chosen varies with the time of year, weather, length of time the soldiers are to stay there, and availability of building materials. Authorized equipment includes: (1) shelter tents (poncho, winter [illegible]); (2) heavy tents (heavy soldiers' and heavy officers' tents, 1940 model); (3) standard tents: tent USP-41 (standard sanitary-engineering tent, 1941 model), tent USB-41 (standard sanitary-barracks tent, 1941 model), auxiliary tent.

Depending on the purpose, a distinction is made between summer and winter tents, the latter being equipped with heating devices (e.g., winter [illegible]). There are also summer-winter tents. Auxiliary tents are available for storehouses and power plants.

Due to the use of nuclear weapons in modern warfare tents have to be set up in covered positions.

Screens -- sloping or vertical barriers -- are used chiefly as a protection against the wind; along with bonfires they help to keep people warm. They are normally used during temporary halts.

Shacks designed to provide shelter against the wind, intense heat or cold are much more effective and comfortable than screens. The difficulties involved in building them and the substantial amount of materials required are worthwhile only when the troops are to rest in one place for a comparatively long period of time.

In the absence of building materials in the winter a variety of structures may be made out of snow and ice. The simplest type of shelter is a snow hole in which the air temperature may be raised about six or eight degrees because of the heat coming from the people themselves. A hole is dug into deep snow and roofed over to a height of 1 m with poles and pine needles. Above the pine needles is heaped a layer of snow 0.5 m thick. Six men can be accommodated in a hole 2 x 3 x 1. A hole can be dug in fresh wet snow.

Entrances to the holes are made as small as possible and are curtained off by tent panels or obstructed by blocks of snow which are set on skis and pulled up in front of the opening.

Soldiers can stay for a little while in a snowdrift out of which foxholes have been excavated. If there is no snowdrift, a bank can be made of packed snow.

Igloo-type snow or ice shelters can be used for personnel, storage of supplies, clothing, and equipment. They are made of blocks of snow 70 cm thick with no sheathing. If poles are available, snow shacks can be made with a frame of poles. Wet snow 20 to 25 cm thick serves as the covering.

To house soldiers for a longer period of time (from one to three months), ice-snow structures are erected. Soviet engineers have worked out standard sections 4 to 5 m long. These sections can

be built up so that even barracks can be made from snow and ice. The heaters are shielded by tents, reed mats, pine branches, etc., in order to protect the ice-snow walls from radiant heat. The sections are made either with arched roofing or with a ceiling of poles 8 to 10 cm in diameter. If the former, the sheathing is wood or snow in the form of a solid mound.

Dugouts

Dugouts are the best type of field structure for prolonged stays. They provide reliable protection against the cold and rain and are absolutely indispensable, especially in the winter. Answering the objection of foreign hygienists that dugouts are unhealthy, N. I. Pirogov wrote that like any other living quarters they may or may not be harmful depending wholly on the method of construction.

World War II dugouts were built to house troops, medical stations, field hospitals, headquarters, depots, and workshops. In 1942 a major field hospital was set up in dugouts in the Vyaz'ma region.

Dugouts are essentially a shelter from the weather. However, in war they are often used to protect personnel from rifle fire, shell fragments, mines, and the destructive effect of shock waves.

If nuclear weapons are used in the event of war, dugouts may play a role not only as field quarters but as defense installations (set more deeply into the earth).

According to D. N. Kalyuzhniy and V. E. Stammer, during World War II most of the dugouts accommodated four to eight men each. At the front the dugouts were generally small due to the need of dispersal in order to reduce losses from artillery fire and air raids. Small dugouts were also safer and sturdier. Finally, it was easier for the soldiers to build small dugouts by themselves since the construction of large installations would have required the assistance of combat engineer units. Consequently, large dugouts were built chiefly in the rear for hospitals, headquarters, etc.

An important piece of equipment in dugouts is a drying room for uniforms and shoes.

Dugouts at the front were ventilated chiefly through the firebox of the stove. Only a few dugouts received fresh air through windows and special ducts.

On the Leningrad front dampness was controlled by the use of collecting wells at the corners of the dugouts. They were effective when the water was removed promptly.

The sanitary qualities of dugouts largely depend on the terrain. Experience has shown that the site should be dry, elevated, and not likely to be inundated by flash floods. The level of ground water should be as low as possible (at least 1.5 to 2 m from the ground). In the winter sites should be chosen where there is virgin snow, in the woods if possible, where the soil doesn't freeze too far down. This is convenient for hiding the dugouts from aerial observation.

Ventilation of Dugouts

Soil air differs considerably from atmospheric air. Its oxygen is sometimes as low as 15% while the amount of carbon dioxide increases to 5% at a depth of 2 m. Deterioration of the air is caused by disintegration of organic matter in the soil.

Soil air is in a state of motion; it may emerge from the soil into the atmosphere and living quarters (especially dugouts). Certain factors are conducive to the penetration of dugouts by soil air. For example, it is difficult for air to escape from the soil at the end of winter if there is an ice crust formed from melting snow. "The line of least resistance" for it is then the dugout. When the stove is stoked, the suction of the dugout, which acts like a vacuum cup, causes the soil air to rush into the dugout. A lowering of the barometric pressure or rise in the level of ground water has the same effect. In the first case air is sucked from the soil, in the second case it is displaced by water from the pores.

Dugouts must be built on unpolluted, well aerated, coarse-grained soil to prevent the entrance of polluted air.

Dugouts can be ventilated by the firebox of the stove or an [illegible]. The latter is a slit running the entire length of the roof filled with brushwood or pine branches. The slit is covered on top with a layer of clay and sod (Figure 17). The result is an air-permeable belt assuring constant ventilation of the dugout regardless of the direction of the wind.

Field Camps

Under the conditions of modern warfare with the employment of atomic and thermonuclear weapons troops will be commonly quartered in the field not only at the front but also in the rear. To keep losses to a minimum it will be necessary to quarter troops in small camps. The camps should be so spaced that in the event an atomic blast occurred two places would not be affected at the same time.

In rugged terrain the distance between camps may be shortened. Folds in the earth and large forests mitigate the effect of shock waves. Level surfaces and open expanses of water, on the contrary, help the spread and destructive effect of shock waves. The danger of radioactive fallout after an atomic explosion makes it necessary to avoid locating a field camp on soil likely to produce dust.

In selecting the site for a camp it is necessary to take into account the need of water for drinking, preparation of food, technical purposes, and extinguishing of fires. Open stretches of water can be used for technical and fire-fighting needs, whereas wells must be found for drinking water.

The site should be a dry, elevated area with ground water level at least 2.5 m from the surface. This requirement is occasioned by the need to dig dugouts 2 m into the earth.

Field shelters of the hermetic type with filter and ventilation equipment are set up near the dugouts to protect the personnel in case of an air raid. Trenches are used to provide shelter if there is no time or materials.

Every camp is required to have a decontamination area. Washing points are set up in every battalion, with field baths being employed for this purpose. The field laundry is the decontamination point for linens and clothing.

Personnel, headquarters, kitchens, medical stations, and other installations must be located in camouflaged dugouts that meet the requirements for defense against enemy use of atomic weapons.

There are four types of dugouts that may be built depending on the terrain, soil, level of ground water, and requirements of atomic defense: deep, semi-deep, hillside, and horizontal (Military plan [illegible]).

The first type is dug 2.2 m into the ground. It can be built on any ground with a low level of ground water. It protects personnel against shell fragments and shock waves. From the hygienic point of view this type of dugout is not too good since it doesn't have enough natural light and ventilation is difficult. It is threatened with dampness owing to its comparative depth in the ground (Figure 18).

Semi-deep dugouts are no more than 1.6 m deep. Hence, they can be built almost everywhere. They are more hygienic than the deep type because they are lighter and less damp and are more easily ventilated. But they are not as effective for antiaircraft and atomic defense (Figure 19).

Hillside dugouts are built on the slopes of hills, sides of gullies, on banks and dikes. Assisted by the terrain, this type of dugout affords good resistance to shock waves and provides protection against shell fragments (Figure [illegible]).

Horizontal dugouts are built in localities with high level of ground water and on rocky soil. They are not as effective against nuclear weapons as the other kinds because they are above-ground.

The supports of all dugouts and inside surface of wallboards and roofs are covered with fire-resistant clay. The under surface of the plank beds is covered with fire-resistant paint. Windows of the dugouts are equipped with folding screens to block out light and provide protection against radiation.

Hygienic requirements are determined primarily by space and cubic volume of air. IEU standards for [illegible] call for 1.15 to 1.30 m^2 of space and 3.7 to 4.2 m^3 of cubic volume per man in a dugout intended to house personnel.

The typical design provides for 1.6 to 2.2 m^2 of space per man depending on the kind of dugout.

When the air is changed once an hour, the CO_2 content will not exceed 0.5%; when changed twice, the CO_2 concentration is halved, etc., to [illegible]. This accumulation of CO_2 is considered safe.

In dugouts for sick and wounded soldiers 2.35 to 3.7 m^2 of space and 9.0 to 11.5 m^3 of air are allocated per man according to the 1941 to 1944 norms (with a one-story arrangement). Experience during the war showed that the norms could be lowered to 1.7 to 2.0 m^2 of space and 6.7 to 7.0 m^3 of air per man (with a two-story arrangement). This means that the accumulation of CO_2 with a change of air once an hour did not exceed 0.35%. It was halved, i.e., 0.175%, with a change twice an hour. For hygienic considerations 3 m^2 of space should be set aside for each sick or wounded soldier.

The amount of fresh air in medical dugouts is determined from the formula

$$q = K:(p-a),$$

where q is the amount of air per man per hour; K is the amount of CO_2 released by a man in an hour; p is the maximum permissible concentration of CO_2 in the air of a dugout; a is the CO_2 content of the atmospheric air.

After substituting the corresponding numbers, the formula looks like this:

$$q = 25:(2.0 - 0.4) = 15.6\ m^3.$$

This means that each man requires about 15 m^3 of fresh air an hour.

If, however, the air is changed three times by an exhaust (aerator), the cube of air can be reduced to 5 m^3 ($15.6:3 = 5.2$), which is adequate for war conditions.

In modern war, where there is a definite threat that atomic weapons will be used, the problem of providing dugouts with natural light is very difficult. The fact is no glass can withstand the force of a shock wave (window glass shatters at a pressure of 0.1 kg/cm^2). It is obvious, therefore, that ordinary glass, which produces a vast number of splinters, will have to be replaced with the comparatively safe organic glass or other material, e.g., plastics. To protect glass windows and keep the personnel from being injured by splinters, it will be necessary to open the windows and doors at the signal of an air raid warning and see that they remain secure in this position until the all-clear is sounded.

CHAPTER IV

HYGIENE OF DEFENSIVE FIELD FORTIFICATIONS

Defensive fortifications of the open type include ordinary trenches, communication trenches, and slit trenches for protection against artillery fire and aerial bombardment.

A trench is a long, narrow ditch with breastwork and rear traverse containing rifle pits, machinegun emplacements, etc., and various shelters. A trench protects the soldiers from small arms and artillery fire, as well as from the effect of nuclear explosions (Figure 21). Its slopes afford protection from luminous radiation and markedly weaken the effect of penetrating radiation. It should be borne in mind, however, that an open trench laid out with its long axis to the epicenter of an atomic blast isn't very effective. Sanitary facilities in trenches include niches for storing food and water, latrines, water-absorbing and water-collecting wells, and drainage ditches.

The slopes of trenches in shifting ground are bolstered with poles, boards, brushwood, and other available material to ensure greater resistance to shock waves. The revetment is coated with clay or lime as a fireproofing measure.

Niches to store food and water must be shielded. Niche covers are coated with clay or waterproof material.

If trenches are located on the slopes of hills, ditches are dug 10 cm deep and 20 to 40 cm wide along the bottom to trap and carry off draining water.

Drainage ditches covered with boards or poles combat dampness and the danger of inundation by rain and flood waters; sometimes fascines are stacked on the bottom of the ditches (Figure 22). Water-collecting wells 0.75 to 1 m deep are dug in low portions of the trenches. These wells are used when there is a porous soil below a water-impervious layer of earth. If the trenches are near low-lying places, the water is discharged through wooden troughs, brushwood, or stones.

Latrines are usually installed at the dead ends of communication trenches no closer than 15 to 20 m from the regular trenches. Every platoon must have one or two latrines.

Prevention of Frostbite and Trench Foot

Trench foot was a common condition in the English and French armies during World War I. According to R. Green, there were 84,670 cases in the English army. In 1915, 15,900 soldiers in the English expeditionary forces suffered from it at Gallipoli during a November snowstorm.

This disease, which arises during position warfare, is caused by prolonged stay in trenches and the effect of dampness and cold on the lower extremities. It is a peculiarity of trench foot that it can occur and develop when the air temperature is above zero. Predisposing factors are forced immobility of the body, infrequent [illegible] of the legs, wet socks and shoes, tight leggings and shoes. When clothes and shoes are wet, heat regulation is more quickly impaired than when clothes and shoes are dry, even though the air temperature is lower. Wet clothes are better conductors of heat and they remove a substantial amount of heat from the body.

Trench foot doesn't occur only when the air is cold and humid. Cold weather and long periods of time when shoes can't be taken off and dried are conducive to the trench foot type of frostbite.

According to V. S. Gamov, during World War II the maximum peak of frostbites, over 70%, occurred in the winter months (December to February). But there were cases even in November (9.4%) and March (14.6%).

The prevention of trench foot involves, first of all, controlling dampness in the trenches and sanitary conditions. The main thing is to see that the soldiers have warm clothing and dry feet. Consequently, besides drying the trenches, it is necessary to give the soldiers the opportunity to dry out their clothes, change their puttees, and thoroughly dry their boots or shoes.

It is therefore very important to equip blindages and shelters with heaters. Leather shoes must be issued instead of felt boots early in the spring and the shoes replaced with felt boots before the winter. Leather shoes must have thoroughly aired and dried insoles.

If the men are to stay for a long time in trenches, blindages, and other shelters, special physical exercises should be taken to overcome the effects of body immobility. These exercises can be taken, provided that the combat situation permits, without leaving the trenches. The unit commander determines the order of the exercises, the list being drawn up in consultation with the doctor.

Soviet investigators have found that poor blood circulation with resultant oxygen starvation of the tissues is the cause of frostbite. All the conditions conducive to the development of congestion occur in trenches where the soldiers have to remain a long time without moving. Therefore, one of the main problems in the prophylaxis of frostbites is to prevent congestion and the effects of static tension. This can be accomplished by increasing the physical load so as to strengthen blood circulation and raise heat production.

The following hygienic measures are required to prevent trench foot: (1) regular change of socks and puttees with periodic drying of the shoes; (2) daily bathing of the feet with cold water; (3) rubbing of the feet and spaces between the toes twice a day with a wet rag and wiping until dry. These simple measures not only keep the feet in a healthy condition, but also harden the skin, which is one of the most effective ways of combatting colds and preventing frostbites.

Covered Positions

A variety of covers may be used to provide greater protection from mass destruction and enable the soldiers to retain combat efficiency: overhead covers of separate sections of the trenches and communication trenches, slit trenches, niches, blindages, and shelters.

To provide swift cover for the officers and men, sections of regular trenches and communication trenches 6 to 10 m long are roofed with wood and a layer of earth 10 to 50 cm thick. Sloping descents are made at passages from the open to covered sections. Water-collecting wells are dug at entrances to the covered sections. The slopes of the latter are covered with wicker shields, brushwood, rush matting, etc.

Slit trenches are narrow, deep ditches 5 to 6 m long dug in a system of regular and communication trenches or separately. There are open and covered types. In the former, the slopes are covered only in shifting ground; in the latter, they must be covered. The entrance to a covered slit trench is concealed by a screen.

Niches are intended to provide shelter for individual soldiers; they are made of locally available or previously prepared material. The opening is concealed by an attached screen.

Blindages designed to shelter personnel and materiel are constructed by the trench or subterranean method using materials at hand or ready-made parts of reinforced concrete and corrugated steel. The roofs of blindages of the trench type are usually 1 m thick; the layer of earth over blindages of the subterranean type is 2.5 m thick. Blindages have removable plank beds.

Medical supplies, food, and water must be stored in special shelters under modern conditions.

Shelters, unlike the covered positions just mentioned, are hermetically sealed and usually equipped with filtering and ventilating devices. These devices protect the men from poison gases and radioactive substances and prevent them from becoming infected in the event that bacterial aerosols are used. A well-equipped shelter enables the personnel to take off gas masks and eat food without risk of infection or poisoning.

According to F. Rayn, an underground shelter 2.3 m wide with a reinforced concrete roof 40 cm thick covered with a meter of earth is a reliable protection against a shock wave caused by the aerial explosion of an atom bomb equivalent to 20,000 tons of TNT (20 kilo tons). It also affords good protection against gamma radiation. In a ground-level explosion alpha- and beta-irradiation due to radioactive fallout must be considered dangerous.

Shelters are of the trench or subterranean type, depending upon the method of construction. The layer of earth in the former is 1.5 to [illegible] m thick, [illegible] m or more in the latter.

Entrances to shelters have protective doors to blunt the effect of shock waves. Air-intake openings are equipped with special vents or gravel wave absorbers for the same purpose. Openings for smoke have airtight valves. Shelter entrances (direct or elbow type) have one or two vestibules with hermetic partitions and doors.

All shelters and blindages are built on dry, stable ground. The floor is 0.5 to 0.6 m above the level of ground water.

Field shelters under the conditions of modern warfare are hermetic and designed for a small number of persons (approximately 10). They are equipped with double-chamber locks, filters, and wave absorbers (gravel or other construction). The air supply is calculated on the basis of the permissible amount of CO_2 accumulation (not only 1%). In an average shelter 2.5 to 3 m^3 in size 5 m^3 of air per man an hour and a double change will be adequate if it is hermetically sealed. This level of air exchange can be considered quite satisfactory.

Shelters of the field type are heated by stoves of different design equipped with hermetic dampers.

Air Supply in Shelters

A well-built and equipped shelter should protect personnel from various weapons of destruction and enable them to retain their combat and work efficiency. This is to be achieved through a number of hygienic measures, the most important being a good air supply.

A sense of well-being, work and combat efficiency depend on the amount and quality of air reaching the shelter. A relatively long stay in the shelter results in a reduction in the amount of oxygen, increase in carbon dioxide content, rise in air temperature and humidity, accumulation of the volatile products of the decomposition of organic substances with an unpleasant odor. The burning of lamps (candles, kerosene lamps, carbide lanterns, etc.) also befouls the air.

An adult inhales with each breath about 0.5 liter of air. At the rate of 15 to 18 inhalations a minute, ventilation of the lungs of a person in resting state (lying down) is 8 to 9 liters/min; while sitting, the volume of lung ventilation increases to 10 to 11 liters/min; while standing, it increases to 12 or more liters/min. When a hand-operated fan is going, lung ventilation amounts to 18 to 22 liters/min.

The amount of air inhaled and exhaled by people is the main physical factor determining the accumulation of gaseous mixtures and water vapor in a shelter. The amount of air inhaled and exhaled a minute is usually called the respiratory (minute) volume.

It has been established by observations that with each breath a man consumes approximately 28 ml of oxygen and exhales 22 ml of carbon dioxide. Consequently, while resting (15 to 18 inhalations a minute) a man consumes from 26 to 30 liters of oxygen an hour and exhales from 21 to 25 liters of carbon dioxide.

Experiments conducted in shelters have shown that while lying down a man absorbs about 30 liters of oxygen an hour and exhales [illegible] liters of carbon dioxide. While sitting he increases his consumption to 35 liters/hr and exhales 23 liters/hr of carbon dioxide. While standing he consumes 40 liters/hr of oxygen and exhales about 32 liters/hr of carbon dioxide. When a hand-operated fan is going, oxygen consumption rises to 74 liters/hr and exhalation of carbon dioxide rises to 46 liters/hr.

If there is no ventilation and renewal of air in a shelter, the consumption of oxygen and production of carbon dioxide fall. Observations of three persons remaining in a room without fresh air for 2.5 hours showed that the average hourly consumption of oxygen (with a pressure of 760 mm mercury column) was 15.7 to 18.25 liters, exhalation of carbon dioxide - from 19.2 to 24.5 liters (N. P. Brestkin and others).

The extensive observations of N. P. Brestkin and his co-workers made in a hermetically sealed chamber have shown that an increase in carbon dioxide to 2 to 2.5% usually produces no marked changes in the condition of the organism. Under these conditions a man retains his capacity for work and feels fine.

An accumulation of about 4% carbon dioxide intensifies respiration. It is accompanied by increased cardiac activity and reduced capacity for work.

When the concentration of carbon dioxide rises to 5%, shortness of breath develops along with a feeling of asphyxiation. Increased cardiac activity and some intensification of metabolism occur at the same time. Efficiency decreases while physical exertion causes marked feelings of fatigue. Sweating, rapid heart beat, dizziness, and ringing in the ears are occasionally observed.

With 6% carbon dioxide, in addition to shortness of breath there are: gradually increasing apathy, loss of alertness, marked fatigue, inability to perform the simplest physical labor, and striving to hold some bodily position assumed. Reddening of the face, slow pulse, rapid heart beat, dizziness, and headache are other symptoms.

If the carbon dioxide concentration is increased to 7%, a person loses the ability to control his movements.

The noted English physiologist D. Barcroft said that after staying in air containing 17% carbon dioxide for five minutes he was barely conscious of what was happening.

According to N. F. Boyd, an increase of carbon dioxide in the air to 2 to 3% causes rapid respiration; an increase to [illegible] to 6% causes painful shortness of breath; an increase to 10 to 11% causes headaches, nausea, and chills.

V. F. Tsvetsayev, who studied the condition of people in shelters, maintains that the most adverse factor is carbon dioxide. It is responsible for increased ventilation of lungs and changes in the amplitude and frequency of respiration. The magnitude of change is directly proportional to the accumulation of carbon dioxide.

While the concentration of carbon dioxide in a shelter is increasing, the oxygen content is decreasing.

According to the data of M. P. Brestkin and others, a decrease in the oxygen content to 15 or 16% in hermetically sealed chambers has no particular effect on the human organism. This is understandable when one realizes that 15% oxygen in the air of a room corresponds to an altitude of 2.5 km above sea level. Adaptation to living at this altitude is not too difficult if one does not have to engage in heavy physical labor (lifting).

M. P. Brestkin and his co-workers suggest 6.5% carbon dioxide (37.7 mm of partial pressure) and 13.5% oxygen (67.35 mm of partial pressure) as the maximum permissible concentrations for man. Brestkin considers 2% carbon dioxide at a pressure of 500 mm a permissible amount for prolonged stay in the hermetically sealed gondola of a stratosphere balloon. This amounts to 10 mm of partial pressure of CO_2.

The curves constructed by Quakebarth (?) and Dmpson (Figure 23) show that a reduction in the oxygen level and accumulation of carbon dioxide occur evenly and vary with the amount of time people stay in a hermetically sealed room. The air temperature and relative moisture jump sharply at first, followed by a slow rise of the curves, which is due to the condensation of water vapor and absorption of heat by the walls, floor, and ceiling of the shelter.

An increase in the amount of carbon dioxide in the air of a hermetically sealed shelter is accompanied by an increase in the content of malodorous gaseous admixtures.

Amino compounds (methyl, dimethyl, trimethylamine) make up the bulk (90 to 95%) of the organic admixtures in the air of shelters; there is also a small quantity of aldehydes (formaldehyde and acetone). The amount of volatile organic products is 0.5 g (total expressed in milligrams of oxygen used in oxidizing them) per man per day. The amount of ammonia gas produced by a man during a day is 0.2 g.

The curve representing the accumulation of volatile organic admixtures in a shelter shows that after some time further increases in the concentration of amino compounds, aldehydes, and ammonia gas cease because the gaseous products of human vital activity dissolve in condensation water.

Moisture in a hermetically sealed shelter increases rapidly as a result of the loss of a substantial amount of water vapor with exhaled air and through the skin. An adult while resting releases through the lungs and skin about 40 g of water an hour. With physical exertion the water loss is two to three times as much, 80 to 120 g an hour. The average water content in the air is about 8 to 10 g/m^3. Consequently, one person loses in an hour more than the amount contained in 1 m^3 of air. That is why the air in a hermetically sealed shelter soon becomes completely saturated. The ability of air to dissolve water vapor varies with the temperature: the higher it is, the more moisture the air contains.

The amount of condensation water in a hermetically sealed shelter may reach considerable proportions. For example, at 16 to 18° a man loses through the skin from 400 ml to 1 liter of water (an average of 600 ml) a day with light work. Consequently, it is easy to see why there is such a heavy accumulation of moisture in a shelter when people stay there for some length of time. Effective and practicable methods of removing the condensate have not yet been devised. The simplest and most readily available method is to collect and remove it by drainage grooves and collecting wells.

An increase in moisture is accompanied by a rise in air temperature caused by bodily heat. A man gives off 50 to 75 calories while resting or 100 (with light work) in an hour.

Unventilated Shelters

In a modern war shelters should be equipped with filters and ventilators. However, the combat situation may not always permit the immediate furnishing of shelters with these devices so that it may sometimes be necessary to construct unventilated shelters. Hygienically, this type has many shortcomings due to the limited amount of air and the rapidity with which it becomes foul as a result of the breathing of people and burning of lights. Changes in the composition of the air, rise in temperature, and increased moisture and concentration of volatile organic admixtures make the prolonged stay of people in a hermetically sealed but unventilated shelter very burdensome. The main reason is the accumulation of carbon dioxide and decrease in oxygen.

It is generally felt that the oxygen content of a shelter should not drop below 17%. Consequently, one cubic meter of air in a hermetically sealed, unventilated shelter will permit a man to stay there 1.6 hours, as shown by the following equation:

$$\frac{210 - 170}{25} = 1.6.$$

In this equation 210 designates the number of liters of oxygen in 1 m^3 of air; 170 is the permissible oxygen content in the shelter; 25 represents the hourly consumption of oxygen by a man while resting (staying in a shelter).

According to the calculations for carbon dioxide, the time a man can stay in a shelter if he is supplied with a cubic meter of air drops to one hour (20:20=1.0). Here the first 20 designates the permissible accumulation of carbon dioxide (in liters) in 1 m^3 of air; the second 20 shows the amount of CO_2 released by a man at relative rest in an hour (in liters).

A comparison of these two calculations (for oxygen and carbon dioxide) shows that it is necessary to solve the problem of how long a person can stay in a hermetically sealed and unventilated shelter

by another calculation based on the accumulation of CO_2. This latter is also to be preferred because the method of determining CO_2 in the air of shelter is simpler for the doctor to use.

It must be remembered that the maximum CO_2 (2%) concentration is permitted only in hermetically sealed shelters intended for healthy people and for no more than eight hours. If the stay is to be longer than eight hours, the maximum concentration is 1%. In this case one cubic meter of air will enable a man to stay in a shelter only 0.5 hour (10:20=0.5). Here 10 represents the permissible content of CO_2 (in liters) in the air; 20 shows the amount of CO_2 (in liters) released by a man in an hour while resting in a shelter. This accumulation of CO_2 (1%) is also taken as the basis of the calculations. It is used to appraise the condition of the air supply in shelters.

In shelters intended for the sick and wounded the maximum CO_2 concentration is reduced to 0.3 or 0.4%. Consequently, one cubic meter of air lasts only 0.15 or 0.2 hour, i.e., about ten or twelve minutes. This figure is to be employed as a guide in planning the air supply of staff headquarters and communication centers (Table 8).

It follows from this that the supply of air in a ventilated shelter will vary with the CO_2 content in the air that is considered safe on hygienic grounds.

TABLE 8

Safe content of CO_2 in the air	Amount of time for which 1 m^3 of air is sufficient, in hrs.	Amount of air that must be supplied per man per hr, in m^3
2% - in shelters intended for healthy persons for up to 8 hrs.	1.0	1.0
1% - in shelters intended for healthy persons for more than 8 hrs.	0.5	2.0
0.4% - in shelters intended for the sick and wounded, staff headquarters, etc.	0.2	5.0

The required cubic volume of air in a hermetically sealed and unventilated shelter is determined by the permissible CO_2 accumulation, number of persons in the shelter, and length of time of their stay there. The simple formula for calculating the length of stay of personnel in hermetically sealed places can be used for this purpose.

$$T = \frac{10C}{[illegible]}$$

where T is the permissible time of stay in hours; N is the number of persons in the place; C is the permissible CO_2 content of the air as a %; A is the amount of CO_2 released by one person in an hour; v is the area of the place in m^3.

The main health problem in field type shelters is to control the poison gas and radioactive substances brought in from outside on clothes, shoes, and equipment. Desorption of gas and radioactive contamination are highly dangerous. Protective measures include a carefully thought out and soundly organized system of locks and effective ventilation. The more air applied to a shelter, the less danger there is of desorption, the higher the air pressure, and the less danger there is of poisonous or contaminated air entering the shelter. It is particularly difficult to ensure the necessary level of air pressure in wood-earthen shelters where air constantly seeps in through the porous walls.

Ventilated Shelters

Unventilated shelters cannot accommodate people very long. Consequently, to prolong the length of time they can stay there requires a substantial increase in the cubature. But this involves much more engineering work and the greater likelihood of a direct hit on the structure. On the other hand, if only small shelters are built, the permissible carbon dioxide concentration has to be raised, i.e., to worsen the condition of the personnel and endanger their health and combat efficiency. That is why ventilated shelters should be constructed if at all possible.

The ventilator must supply enough air per man per hour so that the CO_2 content in the shelter does not rise above 0.4%. Under combat conditions the permissible CO_2 content may rise to 1% and sometimes even to 2%, but for no more than eight hours.

Figure 21 shows the accumulation of carbon dioxide in ventilated and unventilated shelters with different specific volumes of air and at different intervals of time.

Filtering and ventilating equipment is used to supply fresh air, to purify it of poison gas, radioactive substances, and bacterial aerosols, and to raise the pressure so as to prevent the penetration of contaminated air into a shelter through loose spots in the walls and cracks in the door openings. It consists of a ventilator feeding in air, absorbents to trap the poison gas, pathogenic microorganisms, and radioactive substances, air ducts, and special devices to protect the air inlets from the effect of a shock wave. If no authorized absorbents are available, filters are made from materials at hand. They are usually placed outside the shelter or in the vestibule of the main entrance.

In designing the ventilation of a shelter one must bear in mind that the air has to be supplied by two ducts — one for pure air, the other for poisoned or contaminated air. It is impossible to have

pure and contaminated air come through the same duct since the poison gas aerosol settling on the inner walls of the pipes may be pulled in by the current of air and pass through the filter into the shelter. The duct bringing in poisoned or contaminated air is painted a bright color (red or yellow) to distinguish it from the other duct. The place where it connects with the ventilator has a hermetic valve.

One of the main hygienic requirements for proper ventilation is uniform distribution of fresh air throughout the shelter. The air supplied from the ventilation opening spreads in cone-like fashion, called the "wrapping torch." The maximum speed of air movement occurs along the axis of the torch; the air slows down perceptibly along the edges of the torch. The speed of the air current slackens the further it is from the vent.

If the shelter is fairly long, the walls opposite the vent get scarcely any air. Plank beds, weapons rack, clothes stand, and implements add to the difficulty of securing adequate ventilation. The air must therefore be conducted through pipes so as to leave no dead spaces. This layout is necessary in shelters intended for medical purposes. It is also desirable in shelters for major military units. But it is not required in small shelters lacking plank beds, racks, and other equipment.

All the rooms in a shelter intended to accommodate people for a long time must have direct ventilation, i.e., receive fresh air directly from the outside or through a filter. Auxiliary rooms may have indirect ventilation, i.e., receive air already used in the other rooms.

Indirect ventilation is used to save on air and energy by the supply unit, to provide for the safe ventilation of auxiliary rooms without increasing the volume of air fed into the shelter, and to simplify and cut down on the network of ducts. According to calculations, the ducts should carry the air from one room into another successively not simultaneously (i.e., from a room for people into two or three adjoining rooms at once).

Pressure is increased somewhat in ventilated shelters. The purpose of the pressure is to prevent poisoned or contaminated air from entering. The pressure can be increased only if the capacity of the supply system is greater than the total capacity of the exhaust system taking into account the air consumed by the burning of fuel in the furnace and cylinders of the motor. Excess incoming air is forced through the pores and cracks of the walls, window and door openings. The amount of pressure is virtually constant for every shelter because the size of the cracks and volume of air supply do not change. The pressure rises when the intake is greater than the exhaust.

The vital hygienic factor in a shelter is the movement of air. It is determined by the amount supplied per man per hour. With a minimum supply of 2 m3 per man per hour, the rate of movement is low -- about 1 m/sec. Under these conditions the air pressure in wood-earthen shelters

is minimal. In shelters faced with corrugated iron or in concrete installations where there is less leakage of air, the pressure rises accordingly and may reach the optimum.

Ventilation Methods

If there are no bacterial aerosols, poisonous or radioactive substances outside, the dust is removed as the air is fed into the shelter. If, however, as a result of enemy action, the outside air is contaminated by gas, radioactive substances, or pathogenic microorganisms, it is drawn through filters for disinfection and decontamination.

The principal parts of a ventilation system are intake pipes, ducts, hermetic valves, antidust filters, absorbents, and motor- or hand-driven fan.

The ducts through which the outside air passes to the filter are installed outside the shelter. It is also convenient to place the dust filter there, since as the air is drawn into the ducts and filter, radioactive dust inevitably accumulates and may cause radioactive contamination.

It is forbidden to supply air through pipes contaminated by poison gas or radioactive substances unless it is passed through a filter. Pure air must be drawn into a room through another network of ducts.

To save on electrical power and human muscular energy (in the case of hand-driven apparatus) three types of ventilation systems are recommended. The first supplies air to ventilate rooms and dispel dampness. It is used when there is a lull in the fighting.

The second method supplies air through a filter and removes CO_2 and moisture. Adequate pressure must be assured.

The third method supplies air through filters to get rid of poison gas, radioactive substances, or bacterial aerosols.

The amount of air to be supplied per man per hour is determined by the length of time the people are to stay under hermetic conditions, nature of their work, and state of their health.

Healthy enlisted men and officers staying no more than 12 hours require at least 1 m^3 each per hour. Under these conditions the CO_2 content will be somewhat higher than 2%.

In shelters for the sick and wounded the air is increased to 5 m^3 per man per hour. This is also the norm for those operating hand-driven filter-ventilating apparatus.

Command points, communication centers, staff headquarters, operating and dressing rooms receive a greater amount of air so that the CO_2 content does not exceed 0.4%. This requires the supply of 5 m^3 of air per man per hour.

Regeneration of Air

The air can be regenerated in case the supply is interrupted by a breakdown of the filter-ventilating apparatus, obstruction of the intake pipes, exhaustion of the filters, etc. Special devices are used for this purpose equipped with absorbents for carbon dioxide and moisture. The air can be enriched by oxygen from cylinders containing 5 m^3 of the gas (at normal pressure).

On the basis of average individual consumption of 30 liters/hr, each 40 liter cylinder should last for 166 man hours at a pressure of 125 atm. Efforts are being made to obtain oxygen from chemicals possessing the property of absorbing CO_2 and moisture while liberating oxygen, e.g., sodium peroxide mixed with some other substances.

The device used to regenerate air usually consists of holders filled with CO_2 and water absorbents and oxygen cylinders equipped with reduction valves. The air is drawn through the holders with the absorbents by the ventilator. The shelter must be hermetically sealed while the air is being regenerated.

Heating

Shelters must be heated during the winter. The temperature should be no lower than 10 to 12° to prevent the personnel from becoming chilled due to negative radiation of the wall of the shelter enclosure and covering. The heating devices must be promptly switched off in the event of an atomic or chemical alert. The outside air is warmed up by special devices requiring a minimum of O_2 and not emitting CO_2 and other combustion products. The latter must be discharged away from the inlet openings.

Only smokeless fuel is used to avoid revealing the position of the shelter. The most efficient heater is a metal stove with hermetic doors and outside air fed directly into the combustion chamber.

Lighting

The lighting of shelters is extremely important. For example, during the German cloud gas attack on Baranovich in 1916 many Russian soldiers were poisoned because of the lack of lighting in the dugouts and shelters. Surprised by the gas alarm in their sleep, they were unable to find their masks in the dark (V. F. Shperk).

Lights in defensive installations must meet the following basic requirements: (1) be independent of external sources of power; (2) withstand strong gusts of wind, pressure of shock waves, and air vibration during firing; (3) provide illumination of at least 15 to 25 lux; (4) not pollute, humidify, or heat the air; (5) not consume much oxygen or give off too much carbon dioxide.

The least suitable lights for defensive installations in general and shelters in particular are candles and kerosene lamps. They give off the most carbon dioxide and many products of incomplete combustion that pollute the air. For example, two stearin candles produce as much CO_2 as an adult man.

Consequently, in calculating the ventilation and length of time personnel are to stay in unventilated shelters one must take into account not only the number of people, but also the quantity and hygienic properties of the lighting devices.

Shelters for the Sick and Wounded

If time and resources permit, underground installations are built to accommodate the medical installations. Such shelters are absolutely necessary if the wounded are to be housed and given attention during a battle. Underground shelters are usually built by the engineers in connection with readying a battle site. If the battle is to be fought in a major inhabited locality, they build subways, bunkers, vegetable storage rooms, cellars, etc. In mountainous regions they use for this purpose mines, quarries, natural caves, and artificially created rock-type shelters.

There are five types of underground medical installations: (1) individual shelters for the wounded dug in trenches; (2) light shelters equipped with screens for protection from bullets and splinters; (3) heavy shelters to protect wounded soldiers and medical personnel from shells up to and including 155 mm; (4) reinforced concrete installations of fortified regions planned to withstand artillery and aerial bombardment; (5) shelters of the cave type in rocky terrain.

Hygienically, the most important difficult problem is to supply the sick and wounded in underground installations with air. Each place has intake-exhaust ventilation. Filters are required in the event that the enemy uses atomic, chemical, or bacteriological weapons, the amount of air supplied being determined by the capacity of the devices. The CO_2 content of the air must be maintained at a 0.4% level. This means that each man will get about 5 m^3 of filtered air an hour.

Under exceptionally difficult conditions the CO_2 concentration may be raised to 1% for a short time. The air supply is then reduced to 2.0 m^3 per man per hour according to the formula given on page 64 [of the original]. This restricted air supply is allowed in shelters for the sick and wounded with manual operation of the filter and ventilator.

If the shelter is hermetically sealed and there is no filter and ventilating device, the CO_2 content may be raised to 1% or, for a short time (several hours), to 2%. In this event the length of time the sick and wounded remain in a shelter is determined by the cubic volume of air. If a man gets 5 m^3 of air, the CO_2 concentration of 1% will be reached with 2.5 hours. With a concentration of 2%, the permissible time of stay is doubled, i.e., about five hours.

Shelters intended to house wounded and sick soldiers for a long time must be hermetically sealed and appropriately ventilated. The sealing is done in such a way as to allow the build-up of air pressure, which prevents the entrance of poisoned or contaminated air from without.

All the objects inside the shelter must be set 0.[illegible] to 0.3 m from the walls to counteract air stagnation in poorly ventilated corners, at the walls opposite the entrance, and under the plank beds. The plank beds placed in the middle of the shelter with passages left along the walls. If there are two-tier plank beds, the lower tier is 0.75 m from the floor, the upper tier 1 m from the ceiling. Since carbon dioxide, which has a lower specific gravity than air, normally accumulates from below, exhaust fans have to be placed closer to the floor. In unventilated hermetically sealed shelters it is advisable to keep seriously ill and wounded soldiers suffering from pneumonia or pulmonary edema on the upper plank beds.

A shelter designed for the sick and wounded must have minimally one emergency exit at least 6 to 8 m from the main exit so that it can not be destroyed simultaneously with the main one by the explosion of a single shell. This type of shelter must have special entrances and vestibules to permit the unhampered passage of stretchers. Shelters with no internal supports, i.e., those using corrugated iron, or subterranean shelters are the most suitable for medical purposes.

CHAPTER V

SANITATION OF TROOP LOCATIONS

Barracks Sanitation

The sanitation system of barracks consists of the collection, removal, and disinfection of sewage and refuse.

Sewage and refuse are of epidemiological significance because they keep in viable condition for a long time the causative agents of many infectious diseases (cholera, typhoid fever, paratyphoid, dysentery, etc.). Human or animal excrement pollutes water and soil with the eggs of helminths. Rubbish and food waste lying about a military camp promote the reproduction of flies and rodents, thus helping to spread a number of infectious diseases.

The sanitation of a military camp has to be improvised if it is far from inhabited localities with a sewage system and there is no way of using the facilities. Large garrisons have their own purification apparatus. Small camps use simpler methods including extensive soil disinfection of sewage and refuse. The latter is the principal method in the field. This imposes on medical personnel the responsibility for carefully analyzing the problems of pollution and self-purification of the soil, determination of the standards and conditions for loading it with sewage, and establishment of the indications and contraindications for the discharge of sewage into open bodies of water.

Sanitary Facilities in Barracks without Plumbing

If there is no plumbing in the sanitary units, toilets (air closets) are installed. These toilets may be used only in buildings no more than two stories high. They are placed on the external walls in an extension away from the building proper and separated from the other rooms by a heated sluice.

Each toilet has its own cesspool the capacity of which is determined from the accumulation of sewage per man per year: 0.5 m^3 in residential buildings and 0.15 m^3 in buildings used for social, administrative, or industrial purposes. An additional 0.5 m^3 is allowed annually per man for flushing the bowls and drain pipes.

The size of the cesspool can be calculated from the formula

$$X = \frac{a \cdot b \cdot 1.3}{c},$$

where X is the size of the cesspool in m^3; a is the amount of sewage per man per year; b is the number of persons using the toilet; 1.3 is 30% of reserve in case of entrapment with the removal; c is the number of cleanings of the cesspool a year.

Powder closets may be installed only in one- or two-story buildings. The capacity of the cesspool here is determined with due regard for the filling material: 250 g of peat or 1,500 g of dry vegetable mold per man per day.

Outside toilets for the soldiers are installed in heated rooms with natural ventilation no closer than 15 m from the barracks. A water-tight cesspool of brick, concrete, or rubblestone is planned on the basis of a sewage accumulation rate of 0.5 m^3 per man per year.

Water-tight wash holes of concrete, brick, or rubblestone are built for the temporary storage of slops. Their capacity is determined at the rate of 3 m^3 of slops per man per year.

Refuse bins with a capacity of 190 kg of annual accumulation per man (including outside sweepings) are built to collect and temporarily store solid inside waste.

Sewage disposal fields are used to decontaminate solid and liquid waste. Four open, dry plots with well drained soil are set aside for this purpose 1 km from the camp: two summer, one winter, and one reserve. The capacity of the fields varies with the climate and nature of the soil. It is roughly 1,000 to 1,500 m^3 per hectare per year. The layout and operation of the fields must not be allowed to pollute open reservoirs and ground waters.

Non-disintegrated, dry rubbish is taken beyond the camp and used to fill uneven places in the soil. Special plots next to the sewage disposal fields are set aside to decontaminate decomposing rubbish and solid waste. The load of rubbish per hectare per year is calculated from the following data: (1) in case the rubbish gives off a smell - 1,500 m^3; (2) if scattered - 3,000 m^3; (3) if buried in ditches - 3,500 m^3. There must be two plots used alternately.

As far as hygiene is concerned, it is better to burn rubbish in the furnaces of a central boiler room or in special rubbish burners. These stoves are essential for disposing of unhealthy materials especially during wartime.

According to A. N. Marzeyev, garbage to be burned should not have over 45 to 50% moisture or ash content over 45%. The heat value should not be less than 700 to 800 large calories per kilogram. Garbage should be thrown into the furnace fresh, undecayed, and not too wet or diluted with inorganic material (street sweepings, sand, ash from furnaces, etc.).

It is recommended that military camps with a population of about 3,000 men have garbage burners of the Levinson-Chernoshchekov type with a daily capacity of one ton.

Smaller camps may have a field-type furnace, which has three doors: lower - ashpit, middle - stoking, upper - to clean unburned material from the grate. The furnace has two grates -- a lower one for the fuel, an upper one for loading the garbage. The upper part of the flue is covered with a cast-iron plate on which the garbage is dried off. As it dries, it is pushed by rakes to the upper lid of the furnace and loaded through an opening into the combustion chamber.

Sewage in Military Camps

Different sewage systems are used in military camps depending on the local conditions: (1) smooth flowing, (2) completely separate, (3) partially separate, and (4) mixed.

In a smooth flowing system all kinds of sewage are collected and carried to the place where they are processed or discharged through a single set of pipes.

In a completely separate system the sewage is usually carried through two sets of pipes. One serves to collect and remove fecal matter and dirty industrial discharges, the other flood water and temporarily clean industrial discharges.

A partially separate system is used to carry off dirty water through a covered network of pipes and almost clean water through open ditches.

A mixed system has a covered network to carry off water from baths, laundries, kitchens, mess halls, and work places. Sewage from residential buildings, aid stations, etc., is transported away from the camp site.

A partially separate or mixed system is usually set up in military camps for economic reasons. Other systems are set up if there are special indications therefor.

Four layouts for removing and processing sewage are provided by the instructions for planning a sewer system of the KEU [Billeting Administration] Armed Forces of the USSR, 1947]: (1) transferring of sewage to a municipal network, if possible; (2) discharge of sewage into an open body of water without preliminary processing in accordance with the "Regulations for the Discharge of Sewage into Open Bodies of Water"; (3) mechanical purification of sewage (grates, settling) with subsequent decontamination (chlorination); (4) biological purification of sewage by means of natural (irrigation or filtration fields) or artificial (biological filters) oxidizing agents.

Grates and sedimentation tanks may be used by an oxidizing station along with irrigation or filtration fields for biological purification. Grates, sedimentation tanks, and secondary sedimentation tanks to disinfect sewage may also be constructed if there are biological filters.

Air filters, air tanks, and methane tanks so popular in municipal systems are normally not used by the military.

In army camps with buildings three stories and higher include in the sewer system all residential buildings, public buildings, and the sanitary units of industrial enterprises.

In buildings two stories or lower a mixed system is generally used with the sewage carried off through a closed network from baths, laundries, kitchens, mess halls, medical stations, and lavatories in barracks.

Residential buildings lacking plumbing have air closets or outside toilets whence the sewage is carried off by sanitary transport (Instructions of the KEU, Armed Forces of the USSR, for Planning a Sewer System, 1947).

Purification of Sewage

The methods of purifying sewage flowing into a local sewer system are planned in conformity with local conditions, taking into account the instructions of the State Sanitary Inspectorate.

Army camps use all kinds of methods of processing sewage: mechanical, biological, and chemical (for bath and laundry sewage). Mechanical methods include: (1) grates and sand traps, (2) various types of sedimentation tanks, (3) disinfection apparatus, and (4) muddy fields. Typical layouts of purifying equipment are shown in Figure 25.

Grates are placed before sedimentation tanks regardless of whether there are pumping stations and before filtration and irrigation fields.

Sand traps are not essential for purification stations. They are used only where there are special indications therefor and usually without drainage.

The settling process may be regarded as the final stage of purification or as a preliminary operation before biological processing. The tanks are primary, unlike the secondary ones used after the biological filters.

Sewage is decontaminated by means of liquid chlorine or chlorinated lime. The required amount of chlorine is determined experimentally (by test chlorination).

Here are the rough amounts of active chlorine required per cubic meter of sewage: 50 to 60 g for untreated matter; 25 to 30 g after septic tanks; 20 to 25 g after primary sedimentation tanks; 5 to 10 g after secondary sedimentation tanks. The sewage is kept in contact with the chlorine for at least 30 minutes.

Muddy fields are located 300 m from residential buildings, if fresh, unfermented sediment is to be dried on them. The distance may be shortened to 75 m, if unfermented muck is placed on them. Natural muddy plots can be found where the level of ground water is no higher than 1 m; if higher, the plots must first be drained.

Sewage is biologically purified by grates and sand traps, sedimentation tanks, biological filters, disinfecting equipment, secondary sedimentation tanks, and muddy plots.

Preliminary settling is not essential if sewage is first purified on filtration or irrigation fields; it is desirable that grates be placed before the fields.

Sewage is conveyed to biological filters after processing in sedimentation tanks. The main material for loading the biological filters is boiler slag. If no slag is available, other filtering materials can be used in larger amounts than the slag: 1.5 times as much for gravel, 1.2 times as much for chipped pebbles or peat.

The loading material of the first layer 0.2 m thick has particles 50 to 70 mm in size. For the second layer 0.5 to 1 m thick the particle size is increased to 30 to 40 mm. The third layer 0.8 m thick consists of particles measuring 20 to 30 mm.

The load of a biological filter is 1.5 m thick, if located in a building, and 2 m thick if in the open.

In calculating the biological filters, it is considered that the biochemical requirement of sewage for oxygen per soldier serviced by the sewer system amounts to 40 g a day.

The oxidizing power of biological filters from boiler slag per cubic meter of load in grams of oxygen is calculated from Table 9.

TABLE 9

Mean annual temperature °C	Oxidizing power of biological filters: In a building	Outdoors
Up to 2	200	—
From 2 to 3	200	150
From 3 to 7	250	150
From 7 to 10	250	200
Above 10	—	300

The intervals between two irrigations of the surface of the filter are 15 minutes apart based on the mean hourly flow of the sewage.

On the site occupied by purification installations it is necessary to build rooms to store and dry the workers' clothing, lavatories, and showers (in large installations).

Filtration and Irrigation Fields

If sewage must be given full biological treatment, portions of the camp site are set aside for filtration or irrigation fields. Filtration fields may be used to purify both settled and unsettled sewage.

Filtration and irrigation fields are placed 500 m from the edge of the camp. Sewage carried off from the fields is not disinfected. Filtration fields do not require natural soil; it is also possible to do a fill layer of sand unlike sanitation or plow fields with crop rotation. Emsherovskiy wells require sewage purification in biological filters.

The useful area of filtration fields is determined by dividing the daily volume of sewage by the mean daily load of the field, the rating of which varies from 40 to 125 m^3 per hectare a day depending on local conditions.

The useful area of irrigation fields is computed on the basis of an average load of 20 to 65 m^3 of sewage per hectare a day depending on the nature of the soil. If the sewage is first allowed to settle, the loading norms are increased approximately 50%.

The flow rate of sewage in diluting ditches is 0.6 m/sec for unsettled liquid matter and 0.25 m/sec for settled liquid matter.

The distance of irrigation fields from the camp may be reduced to 300 m.

In the winter sewage is allowed to become frozen on irrigation fields to 0.3 m. The depth of freezing may be increased to 1 m on filtration fields.

Filter sumps may be used for discharging wastes from lavatories and baths into the ground. If residential buildings, kitchens, or mess halls have pipes receiving water from an artesian well or pool 50 m or more from the filter sump, the distance between the pipe and filter sump may be shortened by a third, i.e., to 15 m, if the water-bearing horizon feeding the artesian well is covered with a thick, water-impervious layer of sod.

It is absolutely forbidden to use filter sumps for the discharge of wastes from baths, laundries, and infectious divisions of hospitals. It is also forbidden to use as filter sumps abandoned pits and hollow shafts directly connected with the water-bearing strata of the soil. Filter sumps may not be installed in rocks with cracks or in coarse-textured (pebbly) soil.

Camp Sanitation

The medical service is charged with exercising systematic control over the execution of the following measures: (1) neat maintenance of toilets; (2) prompt cleaning of cesspools (which may be filled to two-thirds of their capacity); (3) disinfection and deodorization of toilets and cesspools and adjacent territory; (4) removal of soapy water from the camp site; (5) collection and decontamination of garbage; (6) prompt cleaning of drain pits and manure storage places; (7) correct maintenance and utilization of the sanitation transport serving the camp; (8) layout and operation of plow, irrigation, and sanitation fields.

All these steps are taken in order to prevent the camp site from becoming infected by pathogenic microorganisms.

If there is no sewer system, special attention is paid to the layout and maintenance of toilets. A properly constructed toilet is no closer than 75 m to the tents or barracks, has a cesspool and floor impervious to sewage and tightly closing doors, is well illuminated day and night, and is properly ventilated by exhaust pipes (Figure 26).

Each company has a toilet 20 m^2, one hole for each 25 men and 0.5 running meter urinal. The size of the cesspool is fixed at 200 liters of solid and liquid sewage per man for the entire camp period. The cesspool must be cleaned at least twice during the summer. It should not be

over 3 m deep. Concrete and reinforced concrete cesspools are built with walls and bottom at least 15 cm thick. Brick cesspools are made of well-burnt bricks on cement mortar with cement plaster along the inner surface and a wall thickness of one brick.

Wooden cesspools are made of 15 to 18 cm beams on tar caulking with a slab floor. The walls and bottom are covered on the outside with a layer of soft clay 0.5 m thick. All the leaky places in the frame are smeared on the inside with tar or pitch besides double tarring of all the wooden parts of the cesspool.

The capacity of a cesspool with monthly removal of the sewage is determined from the formula

$$Y = \frac{0.5 \times P}{12},$$

where Y is the capacity of the cesspool; 0.5 is the amount of sewage per man per year in m^3; P is the number of persons using the toilet; 12 is the number of months in a year.

The depth of the cesspool is usually increased about 0.5 m in case of interruptions in the operation of the sanitation transport.

If there are indications of an epidemic, the cesspool is usually disinfected with solutions of chlorinated lime.

To control flies, it is necessary that sewage receptacles be tightly sealed, the cesspool kept dark, and a cover provided for each hole.

To prevent pollution and infection of the soil and, through it, of the water, it is absolutely forbidden to install on a camp site cesspools and drain pits of the absorbing type or to dig slit trench latrines. All manner of sewage and waste must be carried off by sanitation transport or removed through pipes beyond the camp. It is not permitted to bury sewage or waste on camp grounds.

To decontaminate the contents of cesspools, sanitation fields are laid out no closer than 2 km to the camp. The area set aside for these fields must be in an elevated place, exposed to the sun and wind, with a low level of ground water. The soil should permit the entrance of liquid sewage. The most suitable kind of soil is sandy loam; clay soils and peat bogs are unsuitable.

A swampy plot must first be drained.

A sanitation field must have two sections so that they can be loaded alternately. It is plowed to a depth of 12 to 15 cm before the sewage is brought in. The day after this is done, the plot is replowed to a depth of 20 to 25 cm followed by harrowing. After the soil dries, the process is repeated (one to two months later depending on the weather). Existing standards call for two to four square meters of field space per soldier depending on the nature of the soil.

Disposal of slops. Cooking and soapy water containing fat and soap cannot be disposed of in the soil. Even the most porous soil will inevitably become plugged up and cease to absorb sewage. Therefore, liquid waste must first be purified.

To collect cooking slops, drain pits are dug near the kitchen and mess hall. Their capacity is calculated at the rate of five liters of slops per man per day. Slops cannot be kept more than a week. The wooden walls of the pit are insulated with a layer of clay 0.35 m thick to prevent the soil and ground water from becoming polluted.

The pit has two trap doors, one for dumping in the slops, the other for cleaning the large particles of garbage clinging to the grate. A pipe is inserted to provide ventilation. The inner surface of the frame and bottom are smeared with hot tar.

Kitchen and mess hall wastes and refuse are ordinarily used for cattle feed on the subsidiary farms. Cooking slops containing a substantial amount of organic matter are collected in wash holes impervious to water and disposed of beyond the camp. If the soil is particularly suitable, slops may be dumped as an extreme measure into filtering wells equipped with fat catchers similar in construction to soap catchers.

KEU instructions for non-defensive field installations (1941) recommend the use of receptacles for slops, which are to be filtered through straw, brushwood, gravel or pebbles, the filtrate subsequently being carried off into an absorbing well.

The receptacle is in the shape of a box measuring 0.75 x 0.75 x 0.5 m (height). The bottom of the box is a removable grate of bars 2.5 x 4 cm. The top is made of removable boards 2.5 cm thick with a covered hole 0.4 x 0.4 through which the slops are poured. The receptacle is set on two crossbeams -- sleepers stretched over a ditch. It is filled with filtering material. First, on the bottom on the grate lies a layer of cobblestones, then comes a layer of gravel or pebbles, then two layers of brushwood and straw pressed together by a pair of bricks. After passing through the filter the slops drop into a ditch where they are carried into the absorbing well or supplementary filter of brushwood, reed, and sand. The slops thus treated are discharged into a stream or allowed to run off into some natural feature of the terrain.

Disposal of soapy water. Soapy water can be carried off from lavatories by earthenware pipes or gutters coated with soft clay and covered with boards. The water must be passed through a soap catcher before it is released into a filtering well (for soil decontamination). The soap catcher is a metal receptacle with a grate bottom or a tightly nailed together wooden box with openings. It is filled with excelsior, straw, hay, reeds, or pine branches, which must be replaced daily. The used filtering material must be burned.

Disposal and decontamination of rubbish. Solid food wastes, rubbish, and sweepings are kept in special bins, which are water-tight receptacles of the ground type with secure covers and devices to permit rapid emptying. The size of the bins is determined by the amount of waste and intervals of cleaning, which should not exceed seven to ten

days. There are about 60 kg of rubbish by weight or 0.2 m^3 by volume per soldier for the entire summer encampment. The bin should not be made higher than 0.7 m for ease of loading and cleaning.

Dry rubbish in a camp can be collected in heaps and burned beyond the confines of the barracks and tents on the lee side in special furnaces or in improvised incinerators.

An incinerator must be designed so as to take cognizance of two principles: free entrance of air and retention of heat.

In setting up an incinerator, the following must be kept in mind: (1) it must be placed on a water-impervious platform made of concrete or well-packed earth; (2) the air openings must be shaped like funnels narrowing toward the inside to ensure a good draft; (3) the grates must not be fastened, but must lie loosely on supports; (4) the loading openings must be arranged in such a way that fresh material can be added from above; (5) the openings for cleaning must be fairly spacious so that the ashes can be easily raked out and the inside of the furnace cleaned; (6) a covered incinerator must have a long pipe to ensure a good draft; (7) to use the heat, it is advisable to cement in a water tank.

The method of soil decontamination of rubbish is very common in the Soviet Union. It is often used in constructing roads, filling uneven places in the ground, plowing, etc. According to R. A. Babayanets, city rubbish containing a substantial amount of organic matter is satisfactorily mineralized in the soil when dumped at the rate of 400 tons per hectare. It is covered with a 20 to 50 cm layer of soil to prevent the breeding of flies, eliminate odor, and control dust.

The size of the plot used for decontaminating rubbish varies with the kind of soil and method of dumping. If dumped in a 20 cm layer, 3 m^2 of space is required per m^3 of rubbish. At this rate 200 m^2 or 0.02 ha of space is required for each thousand soldiers producing about 50 tons of rubbish during the camp period. If a 10 to 15 cm layer is plowed in the plot is increased to 0.8 ha.

Biothermic methods of decontaminating waste. The nature of camp life makes it possible to use biothermic methods for decontaminating waste. These methods combine rapid and total decontamination with utilization of the waste as fertilizer in agriculture. Hygienically, biothermic decontamination is particularly valuable because it quickly kills off pathogenic microorganisms and helminth eggs.

Biothermic methods of treating waste include composting and chamber methods.

Composting is the process of making piles of waste containing a substantial amount of organic matter. Self-heating of the waste takes place as a result of the activity of thermophilic microorganisms with the entrance of air and difficulty of heat emission.

M. N. Tukalevskaya's data indicate that self-heating of compost piles varies with the size, composition, and thickness of the material and with the conditions of composting. For example, compost may warm

up to 50, 30, or 25°. According to A. N. Marzeyev, regardless of the external temperature, the compost pile temperature rises to 40 or 50°, sometimes even to 60°, gradually dropping within a few days. At 50° non-sporogenous pathogenic microorganisms begin to die off together with the eggs of helminths (45° and above). The larvae of flies die off at high temperatures, but remain alive at relatively low temperatures. Hence, the piles need to be covered with insulating material on top, on the sides and front end. Ripening of the compost requires five to twelve months depending on climatic conditions. The result is valuable fertilizer, odorless and free from pathogenic microorganisms, helminth eggs, and fly larvae.

The site for compost piles in a camp is selected behind the third line on a level spot of ground that can't be inundated by rain or flood waters. A layer of soft clay is placed on the ground and a ditch dug around it.

The waste to be given biothermic treatment must contain at least 30% organic matter and no more than 25% inorganic matter. The minimum moisture is 40 to 45%, the maximum 70 to 75% (N. V. Vinogradov).

In biothermic chambers the processes of decontamination take place more rapidly and at a higher temperature. Biothermic chambers for a camp may be constructed from any available material. There must be: (1) a chamber strictly for loading the waste; (2) insulating material to preserve the heat; (3) ventilating device; (4) devices to remove the liquid formed in the chamber; (5) arrangements for loading and unloading the waste.

For the purposes of aeration and more uniform heating of the mass the corners of the chamber are blocked off in the form of channels, with projections (overhangs) along the sides. A grate is installed 15 to 25 cm above the floor of the chamber. There is also a box-like aerator made of grates one-fourth the height of the chamber. Air openings are made in the sides underneath the grate and exhaust vents in the ceiling. A tent-like device is used to prevent the waste from becoming compacted (Figure 27).

Biothermic processing of waste in a chamber takes from 20 to 40 days. In the summer the chamber temperature reaches 60 to 80° within three or four days; in the winter eight to fifteen days are required.

Figure 28 shows a biothermic chamber of simplified design proposed by G. V. Yeremeyev during World War II. Its small size (about 8 m^3) and shallow depth in the ground (about 1.5 m) make this type of chamber suitable for camps. It has sides which gradually narrow to the bottom and are lined with tarred wood, brick, or stone. Crushed stone, or brick covered with a grate or brushwood is placed on the bottom. The author recommends that a layer of straw, leaves, excelsior, or pine needles 10 cm thick be placed over the cover. Peat or earth is then laid on top.

The chamber is loaded through a hole 30 x 40 cm. Half of the upper covering must be removable to permit withdrawal of the compost.

G. V. Yermeyev advises that two chambers be built at the same time so that they can be used alternately. The chambers are filled up in three to five months depending on the weather.

Biothermic decontamination of waste in camps has great advantages as far as sanitation and epidemic protection are concerned. It guarantees against pollution of the atmosphere and destroys pathogenic microorganisms, helminth eggs, and fly larvae. Biothermic chambers are not too common because of the heavy initial expenses of construction and the need of detailing personnel to maintain them. However, the fertilizing material that they produce is economically worthwhile.

Control of Flies

A fight against flies will be successful if it is directed primarily against the places in which they lay their eggs, i.e., against accumulations of dirt and rubbish, dung heaps, garbage dumps, etc. It requires a well organized system of collection, storage, and disposal of waste beyond the camp confines.

Fly larvae in rubbish bins can be destroyed by the use of hexachlorane (100 to 200 g of hexachlorane per m^3 of rubbish). To prevent the escape of vapors, the rubbish bins must be tightly covered. Hexachlorane is poisonous so it must be handled with care. Above all, it must not be allowed to enter the respiratory tract.

During the course of a summer flies lay 120 to 150 eggs three times in refuse of animal origin, dung, and fecal matter. Larvae develop from the eggs in a few hours (8 to 36 depending on the air temperature) and a few days later pupate. Shortly afterward they become transformed into winged flies. The average time of development from egg to imago, according to Ye. N. Pavlovskiy, is about 45 days at 16°, about 27 days at 18°, 20.5 days at 20°, 17 days at 25°, and a little over 10 days at 30°.

In the fight against flies it is particularly important that the toilets be properly serviced.

Cesspools in camps must be cleaned at times keyed to the stage of development of the flies. To disinfect fecal matter, Ye. N. Pavlovskiy recommends: (1) a 5% aqueous emulsion of creolin applied daily with a hydraulic hose to the feces; (2) a 5% solution of crude, black phenol in naphtha or in water to wet the feces and sides of the cesspool at the rate of 2 to 5 l/m^2; (3) a 20% solution of chlorinated lime or 20% milk of lime at the rate of 10 l/m^3; (4) vat residues (chlorine solvents, benzene polychlorides) at the rate of 3 l/m^3.

To prevent the flies from easily reaching sources of infection, the cesspools must be tightly covered, springs or pulleys placed on the doors of toilets, the holes covered, and the floors washed daily with hot water (Ye. N. Pavlovskiy).

Besides getting rid of the conditions conducive to the breeding of flies, it is necessary at the same time to destroy the winged insects. Accordingly, it is recommended that a solution of pyrethrum in kerosene be sprayed at the rate of 8 to 10 g/m^3; powdered pyrethrum at the rate of 3 to 4 g/m^3 may also be used.

DDT also gives excellent results. The ceilings and walls of kitchens, mess halls, food storage places, and bakeries have to be whitewashed with a solution of chlorinated lime or chalk to which 1% DDT has been added. At least 2 g of active substance must be applied to each square meter of surface. Heat, sun, and other external factors reduce the insecticidal effect of whitewashing, so that it must be repeated two or three times during the summer.

Flies may be destroyed by plywood or cardboard sheets covered with DDT (in a dust suspension, emulsion, paste) and laid on tables and hung on walls and in closets. Surfaces impregnated with DDT preparations are moistened with two drops of a 15% solution of ammonium carbonate or acetic acid to attract the flies.

Recent observations have shown that flies not only do not die if they have only slight contact with DDT or the latter is applied in a weak concentration, but they produce DDT-resistant generations. This undesirable development can be prevented by strictly maintaining the proportion of 2 g of pure DDT to 1 m^2 of surface.

Besides DDT, flies can be destroyed by hexachlorane dust (3 to 12% of the pure preparation) or concentrated emulsions containing 15 to 25% of the preparation. Surfaces are treated with 2% (concentration of pure hexachlorane) aqueous suspensions of dust or concentrated emulsion. Hexachlorane is most effective, but its unpleasant odor precludes its use in residential quarters, kitchens, and mess halls.

Aerosols of DDT and hexachlorane are used for instanteous destruction of flies. Solutions of the pure preparations in mineral oil or Freon are used for spraying. Aerosols can be produced by evaporation of the pure preparation and by burning paper saturated with DDT or hexachlorane. Aerosols remain in the air for two hours and gradually settle on the object to be treated. With the aerosol method of destroying flies 0.1 to 0.12 mg of the pure preparation is evaporated or burned per cubic meter of space (V. I. Vashkov).

Flies are kept away from food by metal screens with 1 x 2 mm mesh or by gauze. Shelves with bread, cupboards with food, and glass cases are covered with gauze. In addition, different kinds of fly traps, sticky paper (effective 3 or 4 days), a 2% solution of formalin and other preparations are used.

Sanitation under Field Conditions

During wartime the disposition and shifting of troops near the front inevitably results in pollution of the soil and, consequently, infection of reservoirs. Inhabited points occupied by troops and bivouac areas, in particular, become heavily polluted by sewage and waste.

The choice of decontamination methods is determined by local conditions and the length of time the troops stay in an area. In all cases and circumstances, however, sanitary requirements must be taken into account.

Ditches 1 m long, 0.3 m wide, and 0.5 to 0.75 m deep are used to collect and decontaminate sewage in the field. One running meter of ditch is dug for each 30 to 40 men; hence two ditches are enough for a rifle company. Boards or poles are inserted to prevent the edges from crumbling and to facilitate the use.

Field ditches should be dug in dry and elevated places 50 to 100 m away from the tents or dugouts and on the lee side if possible.

It must be borne in mind that mineralization of sewage takes place most rapidly and completely in the upper, biologically active layer of the soil. That is why the ditches must be dug no deeper than 0.75 m; if the level of ground water is high, the depth is decreased to 0.5 m. Ditches must not be dug in gullies, low places, or natural terrain features in order to prevent the ground water from becoming polluted and the processes of decontamination from slowing up. To hasten the mineralization and deodorization of sewage and control flies, a 5 cm layer of earth or peat is added twice a day. These tasks are the responsibility of enlisted men on fatigue duty.

If there is an outbreak of intestinal infections among the troops or local population (cholera, typhoid fever, dysentery), the sides and contents of the ditches are disinfected with a 10 to 20% solution of chlorinated lime (two to three liters per m^2 of surface). This work is done by the enlisted man on fatigue duty (under the direction of a feldsher or sanitation instructor). It is recommended that sewage be disinfected twice a day: in the morning after breakfast (before the earth is filled in) and at night. One to two meters of the ground alongside the ditch is also treated with chlorinated lime. It is particularly important that the board or pole reinforcement be disinfected.

A good way of deodorizing ditches and controlling flies is to use naphtha or cresol at the rate of one liter per m^2 of sewage surface.

Earth is added to ditches and tamped down after they are filled to two-thirds or three-quarters of their capacity.

Disposal and Decontamination of Rubbish

A trench, the size of which varies with the amount of solid waste and number of men in a unit, is used to collect and decontaminate rubbish.

To keep away flies and get rid of the odor, each new batch of rubbish is strewn with a layer of earth 5 to 10 cm thick. Observations show that the processes of decontamination of organic waste take place most rapidly at a depth of 1 m.

The best method of decontaminating under field conditions is to burn it in the open or in special furnaces. However, the lack or insufficiency of fuel and the need of concealment limit the usefulness of the method during wartime.

Dry rubbish, litter, and bandaging material from infectious hospitals and all objects of little value infected by pathogenic microorganisms, radioactive or poisonous substances must be burned. Things contaminated by radioactive substances are burned only when there is no possibility of radioactive combustion products entering the atmospheric air. Radioactive ash is buried 1 to 1.5 m in the ground. A sparsely settled region, far from sources of water and not cultivated, is chosen for this purpose. It must be in a high, dry place with low level of ground waters.

A perforated cylinder of sheet iron set up in a field hearth or special stove can be used as an incinerator.

Bivouacs have to be provided with field incinerators if the troops are to stay there for some time. This is called for if there are increased indications for burning unhealthy materials due to the use of chemical, bacteriological, or atomic weapons.

The simplest type of incinerator is a truncated cone of sod or brick with a fire grate on the bottom. It is 1 m high, with a diameter of 0.65 m on the bottom and 0.5 m on the top. An opening 0.25 x 0.25 m is made under the grate for the passage of air. The waste is dumped in from the top after the incinerator is kindled with firewood; fuel is inserted below under the grate.

Field hospitals and temporary encampments should have better incinerators, which can be designed and built by the combat engineers.

Disposal and Decontamination of Slops

Dirty water from kitchens and lavatories may be left on the spot or disposed of beyond the troop area. The main task of sanitary supervision is to prevent the accumulation of sewage and waste and resultant pollution of the air, soil, and water. This is effected by keeping the waste water from the soil and swiftly disposing of it some distance from the troops.

Slops may be temporarily kept in oiled or tarred boxes or barrels. Tightly-fitting covers help to fight flies. The receptacles can also be sprinkled with kerosene or naphtha.

If there are no barrels or boxes or it is impossible to arrange otherwise for the removal of slops, sewage, or rubbish, ditches or pits are dug on the lee side of residential buildings and fairly distant from sources of water. Each batch of rubbish and slops is drenched with milk of lime or a solution of chlorinated lime and sprinkled with earth. The liquid contents of the pits are protected from flies by a thin layer of kerosene or naphtha. The ground near the pits is likewise treated with milk of lime or chlorinated lime.

Under field conditions drain pits can be used to collect and disinfect slops. The fat forming an impenetrable film on the sides must be removed by a fat trap. The simplest type is one made from a perforated bucket, tub, or can using as filtering material excelsior,

straw, pine branches, etc. Fat traps can also be made from tubs divided in two by a partition. Suspended particles settle in the first compartment while the fat is separated in the second compartment, which is filled with straw, green grass, or excelsior.

Surface drain pits can be used when the level of ground water is high or the slops are poorly absorbed by the soil. These are square pits 0.5 x 0.5 m wide and 0.3 m deep with four irradiating ditches 0.3 m deep at the center and 0.45 m on the periphery. Each ditch is 2 m long. The ditches are filled with gravel (from 1.5 to 7.5 cm in diameter). A perforated bucket filled with filtering material is placed in the center.

In a clay-sandy loam soil an absorbing well measuring 1 m^3 is adequate for a company. For long bivouacs it is recommended that two such wells be dug so that they can be used alternately one to two weeks each. This is necessary t. break down and mineralize the organic matter. Thick films forming on the bottom of the well can be dissolved by pouring in 20 liters of a 20% solution of chlorinated lime daily for several days.

Soapy water from lavatories, baths, and laundries is carried off through ditches lined with clay into special drain pits 50 to 100 m from the camp on the lee side. The water is passed through a simple filter before emptying into the pit.

The filtering material is replaced at least every two days and then burned. If it is impossible to construct a filtering device, the soapy water is discharged into a pit where it is strewn with earth every other day or daily if the weather is hot.

Disposal of Cattle Waste and Dung

Cattle must be slaughtered beyond the residential area on the lee side. It is desirable that a field slaughtering point be set up in a barn or some other covered place fairly distant from sources of water.

Special efforts must be made to effect the prompt disposal and disinfection of cattle waste that may contaminate the soil and water. As soon as the cattle are slaughtered, the blood and contents of the stomach and intestine are buried 0.75 meter in the ground. The carcasses of sick and dead animals are drenched with naphtha, resin, tar, or cresol and buried at least 1 m. It is a good idea to line the bottom of the pit with unslaked lime and to sprinkle some lime on the carcass of the animal. Before a unit departs, the top layer of soil around the slaughtering point is disinfected with milk of lime or chlorinated lime and buried in the pit.

Decontamination of Radioactive Waste Products

Radioactive waste products in the field may include radioactive sewage produced at special processing points, soapy water from field laundries after washing robes, workers' overalls, uniforms, or linens contaminated by radioactive substances, used up filtering material at water supply points, radioactive sediment after coagulation of water, and packing material (if contaminated by radioactive substances).

Special care is required to remove and decontaminate radioactive sewage which is formed at special processing points and in laundries where uniforms, robes, and linens polluted with radioactive substances are washed.

Under field conditions it is virtually impossible to carry out the measures to remove and decontaminate liquid radioactive waste products that are available in a municipal system. The main problem in constructing sewers is to prevent the radioactive pollution of the soil and water. Liquid waste products containing short-lived isotopes in concentrations below $1 \cdot 10^{-6}$ C/1 (curies per liter) are allowed to flow together into a filtering well without preliminary processing. If the radioisotope content is higher, the sewage is kept for a day to reduce the activity to the above-mentioned level. Water-tight reservoirs are set up for this purpose next to the special processing point or field laundry (the simplest type is a pit with sides lined with soft clay). The radioactive sewage held there is not emptied into the soil or body of water until it is checked radiologically. If there is a fairly large body of water that is not used to supply the troops, the radioactive sewage can be dumped there. An appropriate mark is made at the water's edge.

If there is no open body of water, a filtering well is dug in porous soil with a low level of ground water (quite a distance away from sources of water).

Sewage containing long-lived radioactive isotopes (strontium, cesium, cerium, uranium, plutonium) may not be emptied into streams or lakes if they have fish or if they are visited by waterfowl. It is forbidden to empty such sewage into creeks feeding rivers or lakes.

Sewage containing long-lived radioactive isotopes in concentrations no greater than $5 \cdot 10^{-9}$ C/1 (for beta emitters) and no greater than $5 \cdot 10^{-11}$ C/1 (for alpha emitters) may be emptied into open bodies of water. If diluted with soapy water to lower radioactivity to the authorized limit, the sewage may be emptied into a river or lake not used for breeding fish or waterfowl.

Radioactive sewage and the places of decontamination are to be monitored. The places where radioactive water is discharged into the soil or body of water must be marked.

Filtering material (sand, gravel, pulverized anthracite, ion-exchange resins) and sediments after coagulation of water containing radioactive substances are buried at least 1 m in the ground. A dry

and elevated place with a low level of ground water is selected for the burial of material that has absorbed radioactive substances. The burial place is given a special marking. It must be located away from inhabited localities and far from wells and open bodies of water.

Used packing material contaminated with radioactive substances is handled in the same way. Bulky materials can be buried in abandoned dugouts, trenches, and antitank ditches. In exceptional cases they may be burned provided that there is no danger of people and animals breathing the radioactive aerosols formed during the process. The same procedure also holds for contaminated bandaging material and the carcasses of laboratory animals. Highly active ash produced by the burning of radioactive material must be handled with great care. Before burial it must be collected in water-tight containers (tightly-covered or corked glass or metal vessels).

All work connected with the collection, removal, and decontamination of radioactive material must be done by trained personnel equipped with masks, rubber gloves and boots, and special clothing. The equipment is decontaminated afterwards.

Final Sanitary Measures

Before a military unit departs from a camp, the command and medical service take a number of steps to sanitize the area. Latrines and drain pits are filled up and tamped down. Dry rubbish and litter are burned, wet waste buried. The top layer of soil at cattle slaughter points and kitchen sites is treated in the same mechanical way. The places where sewage is buried are appropriately marked for the information of new units that may come there.

The burial ground of radioactive materials is monitored. If the level of activity is above the authorized limit, warning signs must be posted.

Sanitation in Defensive Installations

Troops occupying trenches must be provided with latrines and shelter from enemy artillery and mortar fire. To avoid polluting the trenches, latrines are built for each platoon (Figure 29).

Urinals are constructed in addition to latrines for use during an artillery or mortar bombardment and at night. These urinals are filtering pits about 1 m^3 in size filled with gravel or pebbles and covered on top with sand or pulverized earth. Tin funnels (from preserve cans) or wooden trays can also serve as urinals. The pits are dug in dead-end passages of the trenches near the blindages and shelters.

Company sanitary inspectors and battalion feldshers supervise the construction and maintenance of trench latrines.

The odor can be controlled and the flies prevented from breeding by sprinkling the sewage daily with 10 cm of earth and adding a 10% solution of chlorinated lime or 20% milk of lime.

To collect and store rubbish and food waste, pits about 1 m^3 in size are dug next to the toilets and provided with tightly-fitting covers to keep out rodents. The contents are sprinkled with earth every day and treated with a 10% solution of chlorinated lime or 20% milk of lime for the purpose of deodorization.

Unhealthy materials, including those contaminated by radioactivity or poison gas, are buried at least 1 m in the ground. Craters from shells or aerial bombs, abandoned communication trenches, dugouts, or shelters can also be used and then filled up with earth.

Sewage Disposal in Shelters

Sewage in permanent shelters is removed by pipes. If joined to a municipal system, there must be a reliable hydraulic seal. In field-type shelters sewage is removed by buckets, the number and capacity of which vary with the number of people and estimated amount of time they are to stay there. If people are to stay there for 12 hours continuously, the capacity of a waste receptacle for a squad of 12 men is about one bucket. The sewage and receptacles can be deodorized by a 10% solution of chlorinated lime, 20% milk of lime, solar oil, heavy petroleum products, etc.

Battlefield Sanitation

Battlefields are cleaned and casualties collected in accordance with field instructions.

The corpses of Soviet soldiers who die in battles for their country are collected by special teams assigned by the commanding officer of a unit. The teams are charged with responsibility for searching for corpses, registering, collecting and delivering them to a division point for burial. The corpses are buried in common graves in common cemeteries. The bodies of officers may be sent to the rear by order of the commanding officer for burial in individual graves.

Transport is assigned by the unit chief of staff with the required amount of tarpaulins to cover the bodies of soldiers who die on the battlefield and bring them to the collection and burial point. It is absolutely forbidden to move corpses by transportation facilities used for shipping food.

Military honors are accorded the dead in accordance with Garrison and Interior Guard Duty Regulations of the Armed Forces of the USSR.

A doctor or feldsher is assigned by order of the commanding officer or senior medical officer to ensure the sanitary collection of corpses on the battlefield and their delivery to the division point.

The doctor is responsible for:

(1) Medical examination of all the dead before the bodies are sent to the division burial point;

(2) Providing all members of teams collecting corpses with special overalls or clothing, canvas gloves and aprons of closely woven cloth;

(3) Arrangements for disinfecting work clothes with 3 to 5% aqueous solutions of soap-cresol preparations (lysol, silysol, naphthasol, soap-cresol solution, Petrov's petroleum contact;

(4) Arrangements for the personnel to wash and change their clothes after the corpses are collected and shipped;

(5) Observation of the burning of unhealthy materials on the battlefield (dressings and bedding, scraps of clothing, etc.), rubbish heaps, waste in pits (shell craters)and subsequent strewing of earth;

(6) Selection of places to bury the carcasses of animals (horses, dogs, sheep, goats, cows, etc.) on the battlefield in shell craters and antitank ditches with due regard for the level of ground water, soil properties, conditions of air and insulation;

(7) Inspection of wells and open bodies of water to find and remove therefrom corpses and other unhealthy things.

A member of the regimental (division) medical service is responsible for sanitary supervision of the burial of corpses. He is charged with:

(1) Selection of a place for burial of the dead (elevated, not subject to inundation by rains and spring floods, sloping away from the nearest body of water,with sandy, sandy loam, or clay soil, airy, and sunny);

(2) Determination jointly with the commanding officer of the size and depth of common graves,height of burial mound, etc. (burial in common graves is permitted in three to four rows in width and no more than two rows in height);

(3) Observation of the digging of individual and common graves and burial of corpses (the distance from the level of ground water to the bottom of the grave must be at least 0.5 m; the distance from the upper row of corpses to the surface must be 1.5 m, the permissible space between rows being 30 to 40 cm; the mound over the grave must be at least 0.5 m high and covered with sod or stone starting from the edge of the grave so as to keep out rain and thaw water);

(4) Organization of sanitary-disinfection measures after the corpses are buried; arranging for members of the team to change their clothes, daily laundering and disinfection of work clothes and transport facilities with soap-cresol solutions;

(5) Filling out of documents indicating the work performed with a designation of the burial site on a map and detailed list of all the sanitary measures taken in connection with the burial -- in the form of a report to the division medical officer.

The corpses of enemy soldiers and officers are buried separately with observance of all sanitary requirements with respect to choice of site, size of collective graves, arrangement of mounds, etc. The site is chosen by the burial team leader along with a member of the medical service.

Soldiers who die of wounds or illness in military hospitals are buried in individual graves with observance of the established Soviet sanitary regulations. The corpses of infected patients must be disinfected. Accordingly, the bodies are wrapped in shrouds or some other material saturated with a 5% solution of chloramine or lysol or with a 10% solution of chlorinated lime. A layer of chlorinated lime 2 to 3 cm thick is placed on the bottom of a solidly nailed together coffin. The bodies of persons dying from anthrax are buried in individual graves at least 2 m deep.

In case of death from plague the corpses must be burned in a hole 2 m long, 1 m wide, and 1.5 m deep, the front sloping for better intake of air. Fuel (wood, coal, peat) is placed on the bottom in a layer about 1 m thick and soaked with 50 to 60 liters of kerosene, solar oil, tar, etc. (but not gasoline). Another layer of fuel drenched with a combustible liquid is put on top of the corpse. The burning lasts about 12 hours and ends with complete incineration. If several corpses have to be burned, the size of the hole, amount of wood and liquid fuel are increased proportionately.

Brick kilns may be used to burn the corpses of persons and animals if there are sanitary indications therefor.

The carcasses of horses are burned in bonfires of logs 15 to 20 cm in diameter. Some 35 to 40 animals may be placed crosswise in two layers and packed with logs, firewood, and other kinds of fuel. After drenching with solar oil, the fire is ignited and continues 36 to 48 hours (A. I. Zavadovskiy).

According to the French method, corpses are burned in holes shaped like a truncated rectangular pyramid with inverted base. An air shaft is dug in each corner of this pyramid-shaped hole. Fire grate bars are installed 80 cm from the bottom, with access thereto provided by a special trench abutting upon one of the sides of the hole. Solid fuel (shavings, firewood, and coal) is placed on the grate and soaked with kerosene or naphtha after which the corpses are laid on the fuel. Naphthalene or the like is thrown onto the fire to intensify and accelerate the process of combustion.

CHAPTER VI

WATER SUPPLY HYGIENE

Introduction

Water is a factor of the external environment that affects the human organism; it also forms part of the organs and tissues. The physiological role of water in the organism is determined primarily by its function in metabolism. Its physical properties make it particularly important in all the biological processes. The high heat capacity of water inside all living creatures prevents rapid changes in body temperature. Water helps to cool the body by the evaporation of perspiration and moisture from the mucous membranes of the respiratory tract. Water, a universal solvent, with its electrolytic dissociation, high specific inductive capacity, and high dissociation of inorganic substances dissolved in it, is unusually suitable for performing its role in living things. The human body is maximally efficient only if its water content is maintained within relatively narrow limits, despite considerable variability in the daily cycle.

A man loses an average of 2.5 liters of water a day with perspiration, urine, and feces, and by evaporation through the skin and mucous membranes. This amount of water enters the body with food and drink and as a by-product of metabolism. When the air temperature rises or muscular activity increases, water metabolism changes drastically. Note that unlike fats and carbohydrates, which produce a substantial amount of water in oxidation, protein foods require a good deal of water to remove nitrogenous end products, especially urea.

Water with unusual, non-inherent properties and organoleptic characteristics always has an adverse effect on the consumer even if it contains no harmful or unhealthy substances. From this arises the basic task in the hygiene of water supply as formulated over 50 years ago by F. F. Erisman: "To provide the population with adequate amounts of excellent water possessing good organoleptic properties."

An analysis of water and its sources should not be limited to determining the qualities of the water at the time the analysis is made. It is known that certain substances present in water (phenol) when subsequently treated in water supply installations may produce compounds that markedly change its organoleptic properties (chlorophenols). That is why an analysis of water must also determine the influence of those factors which may show up only later and make it unusable.

In setting up the sanitary facilities for military posts, barracks, camps, and other installations, water supply must be regarded as a major element in the planning.

The hygienists must be concerned with more than merely passive calculation of the effect of water on the health of the personnel. They must also be able to validate the assumptions made on the role of water.

Polluted water may well be a cause of such diseases as cholera, typhoid fever, paratyphoid, dysentery, tularemia, infectious hepatitis, and brucellosis. The literature describes cases where animals have been infected with anthrax and glanders through water (by contamination of the troughs).

There were cases of infection with trachoma in pre-revolutionary Russia as a result of washing the hands and face with polluted water from a single dish.

Washing dishes with untreated, polluted water may cause an outbreak of infectious diseases. For example, from 8-15 September 1908 in the Pavlov military academy 60 men came down with cholera only because vats of boiling water were washed with untreated Neva water containing the cholera vibrio (L. Gromashevskiy). It will be recalled that pathogenic microflora usually develop unchecked even in boiling water, being helped by temperature conditions and the absence of competing saprophytes.

According to official statistics, during the war with Japan 23,774 Russian soldiers suffered from typhoid fever and paratyphoid or 32.6 per 1,000 of personnel and 9,548 soldiers or 12.9% from dysentery. It would be incorrect to attribute all the infectious intestinal diseases solely to defects in the water supply. However, many authors note that intestinal infections increase particularly during the rainy season when the quality of drinking water markedly deteriorates because of the seepage of rain water into wells.

During World War I the Russian army had 30,810 cases of cholera, chiefly of water origin. Illnesses among the troops ceased when along with vaccinations steps were taken to improve the water supply (boiling and chlorination of water).

Water-borne dysentery outbreaks occur when fecal matter enters the sewer system. This happens when the regulations for laying sewer and water pipes are violated, when water pipes are connected "directly" to washing apparatus of the sewer system, when open water is polluted by sewage from infectious divisions of civilian and military hospitals, and when drinking water is polluted by thaw water during spring floods and downpours. During World War II there were outbreaks of dysentery when water was made from snow collected from contaminated areas.

G. K. Gurbanov showed that dysentery bacilli entering a large river with waste water may be found as far as 3 km away from the point of entry.

Grigoriev-Shiga dysentery bacilli die fairly quickly in tap water; other bacilli in the dysentery group may survive as long as 210 days.

There have also been cases of brucellosis caused by well water polluted with Brucella. It is now believed that all species of Brucella can survive in water from 40 to 60 days.

Well water has sometimes been the cause of outbreaks of tularemia during wartime. Sick rodents rush to water and pollute it with their e retions and carcasses. Outbreaks of tularemia occurred among soldiers who drank the water. Defective pipes in a water system (a vacuum drawing polluted water into the pipes) are another possible source of infection.

During World War II cases of infectious hepatitis were observed among soldiers who drank water containing the hepatitis virus.

T. Archer reported on an outbreak of infectious hepatitis of water origin in the summer of 1950 in an English camp near Hong Kong. Between March and July 73 soldiers in a unit of 500 men and 8 soldiers in another unit of 150 men fell ill. The cause of the epidemic was the water brought into the camp from two sources that was to be used for (1) drinking and the preparation of food, and (2) for housekeeping and technical requirements. The water supply system was so constructed that when two faucets were opened at the same time the polluted river water could mingle with the pure water. This demonstrates the danger of having two water supply systems in a camp.

Leptospirosis among soldiers is usually caused by drinking water contaminated by Leptospira or using the water for food, housekeeping and hygienic purposes. Bathing in polluted water may also bring on the disease.

It is evident from composite table 10 (according to P. F. Milyavskaya) that the causative agents of intestinal infections may survive in water in viable condition for a long time. Consequently, under field conditions all sources of water likely to become polluted must be regarded as suspect and treated. The only possible exception is properly constructed and equipped tubular wells.

The survival rate of pathogenic micro-organisms in water (in days) is shown in Table 10.

TABLE 10

Species of microbes	Distilled water	Sterile water	Polluted water	Tap water	River water	Well water
Bacillus coli	21-72	8-365	--	2-262	21-183	--
Typhoid bacillus	3-81	6-365	2-42	2-93*	4-183	15-107
Paratyphoid A bacillus	73-88	25-55	--	--	--	--
Paratyphoid B bacillus	27-150	39-167	2-42	27-37	--	--
Bacillus dysenteriae	3-39	2-72	2-4	15-27	12-92**	--

TABLE 10 (continued)

Vibrio comma	0.5-214	3-392	0.5-213***	4-28	0.5-92	1-92
Leptospira	--	16	--	--	150	7-75
Tularemia bacillus	--	3-15	75	92	7-31	12-60
Brucella	--	6-168	2-77	5-85	--	4-45

*490 days after the water was infected by the splenic pulp of a man who died of typhoid fever.
**In water filtered through earth.
***122 after massive infection.

Sources of Water Pollution

During peace time lakes and streams often become seriously polluted so that it is necessary to organize systematic laboratory control of the quality, purification, and decontamination of the water. Surface run-off brings in suspended and dissolved organic and inorganic substances. Following rains during spring and fall floods the amount of suspended colloidal and water-soluble substances increases markedly along with bacterial seeding of the water.

All this must be taken into consideration when choosing the methods of water purification. They must be adapted to the results of sanitary examination of the reservoir and laboratory analysis of the water.

The pollution of water near inhabited localities and factories is more persistent. In inhabited localities the water may be polluted by impurities, waste, and sewage of household and industrial origin. The greater the density of population and smaller the body of water, the heavier the pollution. The danger of pollution is particularly great when the sewer pipes come into direct contact with the water.

In connection with sanitary examination of a source of water intended for troop use, the major concern must be with the possibility of pollution by the population.

A new cause of pollution has developed in recent years -- radioactive waste products of atomic reactors, atomic energy enterprises, and hospitals using radioactive isotopes.

A reservoir polluted by radioactive substances may cause radioactive injury to people and animals following prolonged consumption of the water for drinking, preparation of food, sanitary and supply needs. If radioactive deposits are substantial, agitation of the water by bathing or cattle feeding may also result in radioactive injury to people.

The earth alongside polluted water is also likely to be dangerous because of the entrance of radioactive isotopes into plants and through them into the organism of herbivorous animals. Some radioactive substances (e.g., strontium) are deposited in the roots, leaves, and stems, others in the seeds of the plants.

The behavior of a radioactive isotope falling into a reservoir is affected by a number of factors: its solubility, sorption properties, temperature, pH of the water, etc. The content of this or that isotope in the water varies with the entrance of new radioactive pollutants, solubility of radioactive isotopes and their accumulation in bottom deposits. Water exchange in an open reservoir, i.e., inflow and outflow resulting in dilution of the concentration of substances, markedly affects the radioactive isotope content of the water.

The degree of danger presented by polluted water depends on the life of the isotopes. If the half-life is short, no more than a few hours or days, the reservoir is quickly purified and the water is safe for drinking. Entrance into the reservoir of long-lived isotopes, even in relatively small quantities, is highly dangerous.

The ability of marine organisms to accumulate radioactive substances is of major hygienic significance. The process depends on the properties of the radioactive isotope, specific activity of the water, pH of the environment, relative surface area of the organism coming into contact with radioactive water. The accumulation of activity takes place not only by sorption on the surface of the organism, but also by mineral exchange between the organism and water.

The amount of radioactive isotopes stored in plants, mollusks, and crayfish may be a thousand times greater then the specific activity of the water. The shell of crayfish, scales and bones or fish may contain a thousand times the amount of radioactive isotopes in the water, the shell of mollusks more than ten thousand times as much.

Much radioactive matter is accumulated by plants and organisms growing on the surface of underwater objects. All species of plankton have a high level of radioactivity exceeding the specific activity of water thousands and ten thousands of times.

Thus, a radiological appraisal of a lake or river involves more than an analysis of the water; it must at the same time include a radiometric examination of the bottom deposits, algae, plankton, fish, crayfish, mollusks, etc.

In modern warfare poisonous and radioactive substances, bacterial toxins, and pathogenic microorganisms -- causative agents of infectious diseases in man and animals — may fall into water by chance or by the deliberate action of the enemy. Subject to such contamination are bodies of open water (rivers, lakes, ponds, artificial reservoirs), wells of all kinds, portable and reserve water supplies (if inadequately protected) in cisterns, permanent and field-type reservoirs, and even water in canteens.

The nature and extent of poisoning or contamination of water vary with the size of the water source or reservoir, current speed in the river, degree of protection afforded the well or reservoir against poison gas, radioactive substances, pathogenic microorganisms, kind of material used in constructing the reservoir, concentration of toxic substances or density of the contamination, stability of the poisonous substance or contaminant with respect to external influences and its behavior in water.

Atomic and thermonuclear weapons are another source of radioactive contamination. Atomic bombs, atomic artillery shells and rockets with an atomic warhead exploded in the air, on the ground, or in water are the most dangerous. The radioactive products of an atomic charge, unreacted part of an atomic charge, and artificial radioisotopes created by the action of a neutron flux on the surface of soil and water (induced activity) are a source of radioactive contamination following ground and underwater blasts.

Unreacted (not split) atoms of uranium 235 or plutonium 239 are alpha emitters. Their radiation intensity is slight, but if they penetrate into the respiratory or digestive organs of persons or animals they are a dangerous source of internal irradiation.

The induced activity of the soil and water is caused by the effect of neutron radiation originating in connection with an atomic explosion. Neutrons reaching the ground and water induce the artificial radioactivity of such elements as silicon, sodium, aluminum, copper, and zinc. A good deal of radioactive sodium 24, which radiates beta particles and gamma rays and has a half-life of about 15 hours, is formed in sea water.

With a blast 600 m or more in the air the fallout of radioactive products is scarcely perceptible, if there is no precipitation (rain, hail, or snow). Radioactive contamination of the soil and water in this case is caused by induced activity. After a ground blast the soil and water are invariably contaminated by radioactive substances falling out of radioactive clouds. Radioactive particles of soil raised by an atomic explosion fall out along the path taken by the clouds.

The explosion of a low-power atom bomb causes heavy contamination of the soil and water within a radius of 0.5 km from the epicenter of the blast. An atom or thermonuclear bomb of greater power contaminates the soil and water within a much greater radius.

Atmospheric precipitation facilitates the settling of radioactive dust. An underground atomic or hydrogen bomb raises a tremendous amount of radioactive dust. As a result of neutron irradiation a large quantity of radioactive isotopes of different chemical elements (silicon, sodium, etc.) form in the soil. In addition, many radioactive fission fragments enter the soil.

These products mixed with particles of soil are scattered by the force of the blast to a great distance, causing radioactive contamination of the region. A cloud will form and contaminate the soil and bodies of open water as it is driven by the wind.

With an underwater atom blast almost all the fission products remain in the water. Neutron irradiation causes the formation of a great many radioactive isotopes (sodium, potassium, iodine, bromine, etc.) in the water. Consequently, radioactivity of the water and ground near and within a radius of many kilometers of the blast will be very high. The level will drop with time, but the contaminated area will increase due to the processes of diffusion and intermixing of the water.

Radioactive contamination of the soil and water during wartime may also result from the enemy's use of radioactive substances produced in reactors by neutron irradiation of stable elements. Another source of radioactive substances is the waste products of nuclear fuel in reactors. These waste products, unlike the radioactive substances mentioned above, are a mixture of radioactive isotopes with various properties. They resemble in this respect the radioactive isotopes produced by the explosion of an atom bomb.

Alpha-, beta-, and gamma-active radioactive substances may be used in the form of fumes, liquids, mists, and aerosols. By contaminating the soil, water, and vegetation they can complicate the combat activity of the troops and work of all the rear services.

The entrance of radioactive substances into water directly or through the soil makes it unusable without fairly complex treatment (decontamination). The employment of these substances requires medical personnel to take part in radiological investigation of water sources and in testing the suitability of the water for use by the troops.

In war water may be contaminated by poison gas, pathogenic microorganisms, or bacterial toxins from airplanes, by artillery or mortar fire, or by clouds containing gas or pathogenic microbes. Small reser oirs are in the greatest danger of contamination because it is relatively easy to create there unhealthy concentrations of gas and pathogenic microorganisms. It is virtually impossible to contaminate big lakes, rivers with abundant water and swift currents, and large reservoirs. However, local pollution by sewage from contaminated areas along the shore is quite possible. Wells and reservoirs, unless protected, may also become contaminated. Tubular wells of all kinds are relatively safe from contamination by gas or pathogenic microorganisms (except in cases of sabotage). A public water system can be contaminated by destruction of the pipes or by sabotage.

The extent of pollution of water by poisons depends on the nature of the substances and their state of aggregation. Poisonous fumes and vapors are not dangerous to water; liquid poisons, on the other hand, may pollute the water for a comparatively long time. For example, mustard gas sinks down in water and slowly dissolves, forming thiodiglycol and hydrochloric acid (non-toxic products).

The solubility of mustard gas in water is slight -- about 0.7 mg/l. The rate of hydrolysis is determined by its content in water; with 100 mg/l complete hydrolysis takes nine hours, with 500 mg/l the gas is found in water after 24 hours and more.

Lewisite dissolves even more slowly -- from 0.2 to 0.5 mg/l. But hydrolysis is quicker and toxic products are formed.

Oxidizability and chlorine absorptive power are important factors to be determined by laboratory analysis. Mustard gas, lewisite, and other gases are organic substances which greatly increase the

oxidizability and chlorine absorptive power of water. The amount of chlorides may increase as a result of the hydrolysis of mustard gas, lewisite, and other gases containing a chlorine molecule.

According to S. S. Maksimenko, the oxidizability of water in the presence of mustard gas or lewisite (25 to 100 mg/l) increases to 20 to 50 mg/l of oxygen. The chlorine absorptive power of water increases by 1 or 2 mg of chlorine per milligram of mustard gas.

Sources of Water

Sanitary reconnaissance. There can be no sound water supply system in the field without careful sanitary reconnaissance. The purpose of this reconnaissance is to obtain all the data needed to plan the purification, disinfection, and decontamination of water. It is organized in accordance with the conditions prevailing among the personnel of combined arms unit reconnaissance or by sending out a special party including members of the medical service.

The mission of sanitary reconnaissance is to: (a) collect all the data needed to ensure the quickest, simplest, and safest way of supplying the troops with water; (b) make a sanitary-epidemiological investigation of the inhabited locality in which the water is located; (c) make a sanitary-topographic, radiological, and chemical (for poison gas) examination of the water and surrounding terrain; (d) determine the quality of the water and its suitability for drinking and other purposes; (e) ascertain the need of purifying, disinfecting, and decontaminating the water.

In choosing a source of water for troops, it is necessary to check for the presence or absence of radioactive substances and poison gas, distance from polluted places, rate of flow, ease and speed with which equipment can be installed and camouflaged.

Inspection of a source of water begins with exploration of the surrounding terrain to discover possible foci of contamination by poison gas or radioactive substances. Special attention must be paid to all hygienically dangerous objects that might pollute the water by surface run-off or by seepage through porous soil.

After the surrounding terrain has been explored, the water sources must be analyzed radiologically and chemically. If it is found to be contaminated by a radioactive substance or poison gas, an appropriate notation is made. Such water may not be used until it is purified and decontaminated. When territory is recaptured from the enemy, account must be taken of the possibility that the water has been mined or deliberately contaminated.

An unusual odor or color, presence of dead fish or other marine creatures are signs of poisoning. It is not recommended that the taste of the water be determined if atomic, bacteriological, or chemical weapons have been used. It must be borne in mind that some poison gases and all radioactive substances do not change the external characteristics or taste of water.

A sanitary examination of sources of water must first determine whether atomic, chemical, or bacteriological weapons have been used in the particular sector of the front.

The quality of water may also be affected by the following:

(a) acute intestinal infections and other water-borne diseases among the population and military units using this water;

(b) epizooties among domestic animals and rodents in the area;

(c) unsatisfactory sanitary condition of the nearby inhabited localities.

The report mentions the results of the epidemiological survey of the region or inhabited locality, describes the characteristics of the source of water, and presents the data obtained from a radiological and chemical analysis of the water. In addition, it gives the reconnaissance findings, sanitary conclusions concerning each source of water inspected, and mentions the most suitable sources for supplying the troops. All these data are entered on an index card more or less as follows:

- name of source of water or its number in some system;
- size, amount of water or capacity of the source;
- short description of the source;
- analysis number and evaluation of the quality of the water.

Determination of the flow. Sanitary reconnaissance must estimate the amount of water in order to provide a rough idea of whether there is enough to satisfy the needs of the unit and its subdivisions for drinking, preparation of food, housekeeping, and technical requirements.

The discharge of water (amount flowing per unit of time) in large springs and brooks (up to 5 liters/sec) is determined by means of a pail placed under the stream in such a way as to catch the entire flow. It is recommended that holes be dug or earthen dams made in the river bed for convenience in filling the container. The time it takes to fill the pail or other vessel of known capacity is ascertained from the second hand of a watch. The flow rate is found by dividing the size of the container by the time required to fill it.

The discharge of water in rivers and brooks is determined from the formula (Manual on Field Supply of Water to Troops)

$$Q = 0.5bhv,$$

where Q is the discharge of water per m^3/sec; b is the width of the stream in m; h is the maximum depth of the water in m at the place where the width is measured; v is the rate of flow per m/sec.

The flow rate in a river or brook is determined by means of a float placed on the water. The time it takes for the float to pass between two previously measured points on the bank is noted on a watch with a second hand.

The amount of water in lakes and ponds is roughly determined from the formula

$$W = \frac{abh}{3},$$

where W is the volume of water in m^3; a is the average length of the lake or pond in m; b is the average width in m; h is the maximum depth of the water in the lake or pond in m.

The amount of water in a shaft well is found by multiplying the area of a section of the well by the height of the column of water.

In the case of a circular section, first the diameter of the opening is determined, then the sectional area using the formula r^2. The number thus obtained is multiplied by the height of the column of water to give the amount of water in the well.

The output of shaft wells may be ascertained by emptying the water with a pump, belt hoist, or pails. The time required for the water to reach the original level is noted. The output in m^3/hr is then found by dividing the volume of water entering the well by the time.

Sanitary inspection. The purpose of inspecting a source of water is to detect possible foci of pollution. Sanitary inspection enables us to establish the relationship between epidemiological and sanitary-technical characteristics of the source and the data obtained from analyzing the water. It helps in evaluating the data of chemical and bacteriological analysis of the water, in correctly planning sanitary protection, and in instituting measures to render the source healthful.

In wartime the data obtained by sanitary inspection must be supplemented by the results of laboratory analysis of the water. This is absolutely essential due to the threat of radioactive, chemical, and bacterial contamination.

An organoleptic examination of the water, which makes it possible to determine its transparency, color, taste, and odor, is likewise necessary. Water rendered turbid by an admixture of mineral substances is not dangerous. However, the presence of suspended matter of organic origin suggests the possibility of poison gas contamination. Opalescence in the absence of sediment is highly suspicious. Water colored by organic substances also calls for caution. The odor given off by water heated to 40 or 50° can be easily recognized; it may indicate pollution or the presence of some poison gas.

Odor and taste can be appraised on a six-point system:

0 - no odor;

1 - odor detected by an experienced laboratory technician;

2 - odor perceptible if the attention of a consumer is called to it;

3 - odor detected by a consumer, but does not cause him to complain;

4 - odor causing a consumer to complain;

5 - water unsuitable for drinking owing to unpleasant odor.

A sanitary evaluation of water and the source necessarily includes a determination of:

(a) suitability of the water for the various needs of the military unit;

(b) necessity and nature of measures to purify and decontaminate the water;

(c) amount of work involved in making the sanitary-technical arrangements for using the source of water (cleaning and repair of the well, protection against pollution).

The final appraisal of the quality of the water must be based on a consideration of all the data derived from the epidemiological, sanitary-topographic, and technical examination of the source.

Laboratory Analysis of Water

Water was analyzed and appraised in a laboratory for the first time during the Russo-Japanese War. Disinfection and sanitation detachments attached to army corps had laboratory equipment to make chemical and bacteriological analyses. However, due to the imperfect laboratory equipment of the detachments samples were sent for complete analysis to Harbin, where the hospital laboratory of the field army was located. The mobile disinfection and sanitation detachments usually determined the chemical indicators of pollution (ammonia, chlorides, nitrites, and nitrates).

During World War I the network of hygienic and bacteriological laboratories grew considerably. Besides army and front laboratories, there were the mobile (including railroad) laboratories of the All-Russian Union of Cities, All-Russian Zemstvo Union, and Red Cross. The troops had dry Kamenskiy reagents in tablet form which made it possible to make a chemical analysis of the water on the spot or at the source. As time went on bacteriological analysis became quite common because of the substantial increase in intestinal infections among troops in the field.

At the beginning of World War II the Soviet Army disposed of regimental laboratory kits for making a chemical analysis of water right at the source. These kits made it possible to determine the presence of chemical indicators of pollution and poison gases.

Army laboratories were responsible for checking the completeness of decontamination and for making a preliminary examination of water sources to determine the presence of poison gas. Control of the effectiveness of decontamination was largely a matter of ascertaining the chlorine requirement of the water, fixing the amount of active chlorine in preparations, and analyzing the water for residual chlorine.

At least one liter of water is sent to the laboratory for analysis of the poison gas content. A certificate containing all pertinent data is enclosed with the sample.

Water samples must be sent to the laboratory as soon as possible. Hence, the time the samples are taken must be coordinated with shipping conditions. Speed is particularly important in connection with analysis for readily hydrolyzed poison gas or for bacterial content.

If the water cannot be promptly sent to the laboratory, it is kept on ice or in a thermos bottle and then sent on that way for testing.

Water containing radioactive isotopes with a brief half-life (radioactive sodium with a half-life of 14.8 hours) is also rushed to the laboratory. It must be remembered that the processes of radioactive disintegration simply cannot be delayed. That is why water scheduled for radiometric examination has to be processed immediately.

In order to evaluate the degree of danger presented by water containing radioactive substances, one must know the specific activity of the water, composition of the radioactive isotopes, nature and extent of use of the water by the troops. The degree of danger will depend on whether the water is to be used for drinking and cooking, housekeeping and technical needs, sports and training purposes, whether the source is to be used for a long or short period of time, and whether the specific activity of the water is high or low.

In making a hygienic appraisal of water containing radioactive substances, one must be guided by the maximum permissible limits of radioactive contamination with due regard for the purpose and length of time it is to be used.

The final decision as to the usefulness of contaminated water is reached after inspection of the source. Besides the water itself, the organisms and plants living there as well as bottom sediments must be examined. This is done when the concentration of radioactive substances in the water is high and there are no other sources in the vicinity. If the level of radioactivity is within permissible limits, the water can be used for the time indicated in special instructions. If the level is above permissible limits, the water has to be decontaminated.

It is a characteristic of radioactive contamination that the water shows no external signs of changed properties detectable by organoleptic tests or chemical analysis. It is impossible to observe any changes by examining the banks or bottom. Nor are there any perceptible modifications in the phytoplankton, zooplankton, water flora or fauna.

Samples of sediment are taken from the bottom of a river or lake by means of a glass jar, scraper, or bucket. In the event that it is necessary to obtain samples without destroying the structure of the bottom deposits, special devices (the kind employed to collect radioactive soil) are used.

Besides water and bottom deposits, the complete appraisal of radioactive contamination requires samples of fouling organisms and plants, mollusks, and crayfish (at least 50 g of dried sample). The samples are collected by hand or with the help of some device. The object of investigation is carefully rinsed in water to remove any radioactive residue.

Phytoplankton and zooplankton are good indicators of radioactive contamination of water. Samples of plankton are collected with a plankton net in the form of a cylindrical or conical sack. The amount of plankton must be as large as possible. The samples are preserved in a 4 to 5% solution of formalin.

It is also important to analyze the benthos and fouling (periphyton) specimens, which are other good indicators of radioactive contamination. Benthic organisms frequently found in rivers and lakes include mollusks (fresh-water mussel, mollusk Limnaeus).

Samples of benthos must be collected at places where the river flows swiftly. The periphyton is scraped from a bank or bridge. Crayfish and fish for radiometric analysis may be caught by any method available under field conditions.

Plankton, benthos, periphyton, fish, and crayfish samples are preserved in a 4 to 5% solution of formalin. Large fish are preserved by injecting formalin into the muscle belly.

Deep underground water may contain compounds of uranium, radon, or radium. The presence of natural radioactive elements in water is sometimes used to locate deposits of uranium ore.

Contamination of underground water by radioactive isotopes is very rare. Artificial isotopes can get into artesian wells only if they come into contact with a source of radioactive contamination through a crack in rocky soil. Contaminants may get into a tubular well from above if it is not hermetically sealed on top. Sometimes the cause of radioactive contamination of underground water is the entrance of a radioactive substance into a well during exploration of oil-bearing strata. During a war one must keep in mind the possibility of radioactive contamination of water in a tubular well through an air lift when radioactive aerosols are present at the place of air intake by a compressor.

The danger of radioactive contamination of shaft wells is much greater. During World War II it was frequently demonstrated experimentally that the major cause of bacterial pollution of water in shaft wells is the seepage of impurities from above.

If the soil around a well is polluted, one can expect that radioactive substances will get into the well. Less probable, but by no means impossible, is the entrance of radioactive impurities through soil that has good filtration and weak sorption properties.

Sanitary Protection of Sources of Water

The sanitary protection of sources of water, particularly during wartime, is an extremely important part of the water supply system in the field. In World War II instances of deliberate pollution and infection of wells were frequently noted. That is why the protection of sources of water allocated to troops and rear installations is so important.

Measures have to be taken to prevent the water from becoming contaminated by radioactive substances, poison gas, or pathogenic microorganisms as a result of enemy action. Accordingly, sanitary protective zones are set up where every activity is excluded that might contaminate the water or impair its quality. During hostilities it is essential to provide strict protection for bodies of water and adjoining territory, water supply points, conduits, dismountable apparatus, reservoirs, and means of transporting water. Strangers are absolutely forbidden to enter a sanitary protective zone.

The list of specific measures must be drawn up officially in connection with or combined with an indication of the limits of each zone and the persons detailed to exercise sanitary supervision. Systematic control of the purity of the water is the responsibility of army and front laboratories.

The conditions of modern war require, in addition to sanitary protection of the sources of water, the adoption of measures to prevent them from becoming contaminated by poison gas, radioactive substances, and pathogenic substances.

It is recommended that shaft wells be protected by the use of communicating trenches. For this purpose a trench is widened, its walls insulated, and a cover provided (Figure 30). If it is impossible to build a shelter, the well is provided with a water-tight lid.

Straw mats or snow may be placed on the cover of a well to keep it warm in the winter. In the summer it can be protected by a canvas awning or tent. An awning of whatever material is at hand also must be placed over the pump of a tubular well. A recess dug into trenches for a tubular well is covered on top with a layer of clay and earth.

If shaft wells are contaminated by radioactive substances or poison gas, they must be decontaminated and degassed. Accordingly, mud and sand are scraped from the bottom of the wells. Then over a long period of time water is pumped or bailed out and its activity repeatedly determined and gas content analyzed. The sides of the crib are carefully washed before the pumping begins and, if necessary, the crib is scoured. To avoid the seepage of radioactive impurities and the entrance of gas from the surface, it is recommended that a layer of earth 5 to 10 cm thick be removed within a radius of 15 to 20 m.

A layer of earth is removed from the side walls and surroundings of a spring within a radius of 15 to 20 m in the process of decontaminating and degassing it.

Protective measures are easily carried out in connection with tubular and shaft wells. It is more difficult to prevent the contamination of open water, especially small lakes, where it is fairly easy to create a high concentration of poison gas and radioactive substances. Such sources must be kept under rigid surveillance by medical personnel. They must also be guarded against pollution by discharges from decontamination stations.

After an attack with atomic and chemical weapons the water of all sources exposed to poison gas and radioactive substances is analyzed in the laboratory.

Water sources are protected against radioactive contamination by the disposal of radioactive waste in the vicinity of the water and water supply stations (spent carboferrogel, exhausted ionites, sediment after coagulation, etc.).

Hygienic Requirements for Water

Any sources may be used for troops provided that the water meets basic hygienic requirements with respect to content of radioactive substances, poison gas, pathogenic microorganisms, and bacterial toxins.

The requirements are particularly rigid for water intended for drinking, cooking, and bathing purposes.

Radioactive substances, war gas, pathogenic microorganisms, or bacterial toxins must not be present in drinking water.

In forested and swampy areas the oxidizability of water may be increased to 10 mg/l or more as long as its content of organic matter is of natural origin.

For steppe, mountain, and desert regions the Manual for Field Supply of Water to Troops sanctions an increase in the content of mineral salts up to the limits of taste perception: chlorides - 300 mg/l, sulfates - 500 mg/l, hardness - up to 70°.

Under war conditions guidance for water obtained after purification may be sought in the standards cited in Table 11 (GOST [All-Union State Standard] 2874-54).

TABLE 11

Ingredients	Maximum quantity permitted mg/l
Copper	3.0
Zinc	5.0
Fluorine	1.5
Iron	0.3
Lead	0.1
Arsenic	0.05
Compounds containing phenol	0.001

Transparency of treated water by type has been established at 30 cm; general hardness - not in excess of 7 mg/equiv.

Content of residual chlorine after chlorination - from 0.3 to 0.5 mg/l.

The amount of chlorides in water to be used for drinking and cooking may be around 300 mg/l. Dr. P. I. Yeres'ko described a case where only salt water from the Black Sea (17 to 18.5% salinity) was

used for 34 days, with a daily consumption of 1.5 liters per man. G. Armstrong believes that sea water can be used for a long time if 60% fresh water is added.

The feasibility of using salt water for sanitary-hygienic purposes has now been amply demonstrated -- personal cleanliness and laundering of clothes employing a special soap. Clothes thus laundered must be rinsed in fresh water. Salt water can also be used for decontamination.

Experience has shown that pure salt water can be used to prepare potato soup with meat, fish, or vegetables, rice soup, fish bouillon with potatoes and culinary roots, pearl-barley, barley, millet and other soups, and in the baking of bread and other grain products. The soups shouldn't be cooked too long to prevent excessive concentration of salt (V. Yanitskiy).

The presence of radioactive substances in water above permissible limits makes it dangerous for drinking, cooking, washing, laundering, and technical purposes.

However, the harsh circumstances of war may make it necessary to use contaminated water for some time. The time will vary with the level of water activity. According to foreign data, the possibility of drinking water containing radioactive isotopes for 10 to 30 days is determined by the following indicators (Table 12, taken from Nucleonics, No 9, 1951).

TABLE 12

Permissible amounts of a mixture of radioactive fission products in drinking water

Type of radiation emitted by isotopes	Permissible concentration in microcuries per ml immediately after a blast			
	Duration of consumption (with acceptable risk)		Duration of consumption (with safety)	
	10 days	30 days	10 days	30 days
β - radiation	$9 \cdot 10^{-2}$	$3 \cdot 10^{-2}$	$3.5 \cdot 10^{-3}$	$1.1 \cdot 10^{-3}$
α - radiation	$5 \cdot 10^{-3}$	$1.7 \cdot 10^{-3}$	$2 \cdot 10^{-4}$	$6.7 \cdot 10^{-4}$

(D. Garsh, S. Tsirro, and A. Dal')

Total permissible -activity in drinking water after an atomic blast

Duration of consumption	Beginning of consumption	Total permissible β-activity (in microcuries per ml)
10 days	0.5 day after the blast	$1.8 \cdot 10^{-1}$

TABLE 12 (continued)

10 days	1 day after the blast	$6 \cdot 10^{-2}$
"	2 " " " "	$2.4 \cdot 10^{-2}$
"	10 " " " "	$1 \cdot 10^{-2}$

It must be borne in mind that the total activity of the water expressed in microcuries per unit of volume does not give a true picture of the danger to man resulting from its consumption. It is well known, for example, that 40 mg of plutonium is extremely dangerous, whereas 40 mg of radioactive iodine is not too significant.

Water for baking bread, processing food products, cooking, washing of dishes, etc., must not contain radioactive substances or poison gas above the permissible limit, pathogenic microorganisms, or toxins. As far as physical properties (transparency, color) and salt composition are concerned, the requirements may be less rigorous.

Water for washing, showering, and laundering of clothes must not contain radioactive substances or poison gas above the permissible level. Extremely hard water, which uses up a great deal of soap and makes washing and laundering difficult, is undesirable.

Drinking water containing more than 10 intestinal bacilli per liter or more than 100 microorganisms per ml must be disinfected by boiling or chlorination.

It is well to remember that the use of pathogenic microflora by the enemy may render water dangerous for the troops despite the presence of a favorable coli titer and lack of a significant number of microorganisms.

The quality of the water is scarcely evaluated any more from the number of colonies. Such a count has conditional significance as an indicator of changes in the water from a particular source due to local conditions. Even less significant is the salt composition, which may vary markedly in accordance with geographic, geologic, and climatic factors.

Norms of Water Consumption

The water supply plan for troops under battle conditions must be worked out according to water consumption norms. These norms must not be regarded as fixed for all combat situations. Experience at the front generally leads to substantial modifications depending on the nature of the combat operation, presence and quality of sources of water, nature and method of feeding the troops, time of the year, etc.

Estimates of daily water requirements in liters per man, as specified in the Instructions for Water Supply Planning, are presented in Tables 13 and 14.

TABLE 13

ESTIMATES OF WATER CONSUMPTION IN RESIDENTIAL QUARTERS, DINING HALLS, AND BAKERIES*

Type of water consumption	Norms of water consumption per day per man (in liters)	
	In objects with drain pipes	In objects without drain pipes
In residential quarters:		
- for washing	11	6
- for keeping the quarters clean	9	6
- for flushing toilets	15	-
In mess halls:		
- for drinking	3	3
- for cooking, processing products, washing dishes, etc.	18	12
In a bakery	2	2

TABLE 14

ESTIMATES OF WATER CONSUMPTION IN HOSPITALS, AID STATIONS, BATHS AND LAUNDRIES*

Type of water consumption	Norms of water consumption per day per man (in liters)	
	In objects with drain pipes	In objects without drain pipes
In hospitals, and aid stations on the basis of 250 l a day per bed with 2% of the beds from the number of patients $\frac{250 \cdot 2}{100}$	5	5
In a bath, at the rate of 4 visits a month, with 25 bathing days, average	24	20

TABLE 14 (continued)

In a laundry, on the basis of 9 kg of clothing per man a month, with 25 washing days, consumption per kg of dry clothing per washing:		
(a) with hand laundering 35 l	--	13
(b) with machine laundering 60 l	22	--

*From the Instructions for Water Supply Planning, Voenizdat, 1948.

One liter of water is used up in baking one kilogram of bread in a field bakery.

Forty-five liters are calculated for a bath (shower) per man. The same amount of water is required by one man for personal hygiene.

With hand laundering one set of linen requires 35 liters of water, 60 liters with machine laundering.

In a field slaughterhouse 150 liters of water are expended per head of cattle, 50 liters for each sheep or goat.

Means of Storing and Transporting Water

Water is stored and transported in the field in authorized receptacles of rubberized cloth and other kinds of available containers suitable for this purpose. Authorized receptacles (Figure 31) for storing, treating, and transporting water at the disposal of engineer troops of the Soviet Army are listed in Table 15.

TABLE 15

Type of receptacle	Purpose of receptacle and salient data
Wineskin, 12.5 liter capacity (RB-12.5)	Used by a soldier to carry water or to be transported by pack animal. The pack outfit consists of 4 skins. Weight 1.2 kg
Sack-barrel, 100 liter capacity (Re-100)	Used to store and transport water by automobile (24 items). Weight 6 kg
Neckless cloth receptacle, 100 liter capacity (BTR-100)	Used to store, treat, and transport water. Weight 5 kg

TABLE 15 (continued)

Receptacle, 6,000 liter capacity (RE-6,000)	Intended to store and treat water. Weight 60 kg
Receptacle-tank, 1,200 liter capacity (RTs-1,200)	Intended to transport and store water. Weight 35 kg
Metal tank truck	Used to transport water

Water may be transported by plane or helicopter in RTs-1,200 tanks, RE-100 sack-barrels, BTR-100 receptacles, and 20 liter fuel cans. Water may be dropped from a plane (by parachutes) in a special IL-TZh-120 container with a 120 liter capacity. Sanitary inspection of the container, cleanliness, and disinfection is the responsibility of the medical service.

Before disinfection receptacles and tanks are carefully cleaned and washed. They are then filled with water to which a 5% solution of chlorinated lime has been added in sufficient amounts to make a concentration of active chlorine of at least 20 mg/1. The water is stirred and then left alone for 30 minutes. The containers are emptied and rinsed with water until the chlorine odor disappears. The cloths and covers of the RE-6000 are disinfected by being rubbed with rags dipped in a 5% solution of chlorinated lime.

The container for storing boiled water must always be covered. Water is drawn through faucets for analysis. Boiled water is not stored more than 24 hours; if it is necessary to extend the time, the water has to be chlorinated.

Improvised containers obtained from local authorities or borrowed from the population must be cleaned and disinfected with a 5% solution of chlorinated lime under the supervision of medical personnel before they are used.

Supplies of drinking water must be stored in closed containers and adequately protected against infection and contamination by radioactive substances or poison gas.

Water must be chlorinated if it is to be stored for any length of time. Chlorination is done in such a way that there is a minimum of 0.3 mg/1 of residual chlorine in the water and a maximum of 0.5 mg/1. This requires daily checking of the amount of residual chlorine and compulsory analysis before it is supplied to the consumer. If the content is above 0.5 mg/1, the water is dechlorinated. Water to be transported for some distance is also treated with chlorinated lime.

During wartime odor may be used as a test for chlorine in the absence of indicators. The presence of chlorine indicates that the water is safe.

Field kitchens and thermos bottles intended for the delivery of hot food may be used to transport water to the troops.

Water is sometimes stored in the field in reservoirs dug into heavy clay or rocky soils. The sides and bottom are lined with water-repellent cloth. The facing of the sides is brought out to a point 10 to 20 cm above the edge. Sheds are placed over the reservoirs as a protection against pollution and heating of the water in the summer; they are kept warm in the winter with straw, pine branches, or snow. Cloth receptacles and water barrels are kept from freezing by being moved to heated tents, huts, or dugouts.

In the winter water may be shipped without heating arrangements only when the container is in the open for no more than six to eight hours. A 10 cm layer of hay, pine branches, or sawdust on the body of the trucks is used for long-distance transportation of water in non-rigid containers (RTs-1200, RE-100). Tanks must also be covered with straw mats, pine branches, or a layer of snow 30 cm thick. Care must be taken while the containers are being filled to prevent the insulating material from getting wet. In freezing weather it is not recommended that a rubber container with a small amount of water be left outside because it may become solidly frozen.

Improving the Quality of Water

Providing troops with water suitable for drinking and cooking is one of the oldest problems in military hygiene. Every military commander in the past fully understood the importance of a continuous supply of water to troops on the march and in bivouac. Camp sites were always chosen with a view to the accessibility of good water in adequate amounts. Fortresses were generally built near sources of water. If there were none, wells were dug, sometimes very deep. The presence or absence of water determined the line of march of military units and armies.

Efforts have been made from time immemorial to find ways of improving the quality of water during campaigns when it was necessary to use any sources that might be available. Water purification in the pre-bacteriological era meant clarification so that a great deal of attention was paid to the search for filtering media and devices.

"When troops are stationed in a country without good water, a variety of methods must be used to make poor water suitable for consumption," wrote Akim Charukovskiy, one of our oldest military hygienists. In his Military Field Medicine (1836) he described various ways of improving drinking water by filtration through sand.

T. Lovits (St. Petersburg, 1791) described a way of purifying water with powdered coal and oil of vitriol (sulfuric acid).

During the Patriotic War of 1812 the Russian army made extensive use of filtration through soil. A small channel was dug very close to a river or lake and connected to it by a perforated box filled with sand.

In his "Remarks on Protecting the Health of Soldiers," I. Engel'n (Handbook of Military Hygiene, St. Petersburg, 1813) described a way of purifying water that he specially recommended for fortresses. The water was filtered through "two tapering felt or canvas sacks, one 1/4 of an arshine under the other." The upper sack was filled with sand, the lower with powdered coal. Noteworthy here is the use of coal to improve the quality of water.

Charikovskiy discussed a method of purifying water involving the use of a mixture of powdered coal and pure sand as filtering material.

Thus, the "coaling" of water as a means of purification and improving its taste was known to Russian military hygienists 160 years ago. The first monograph on the subject was published by T. Lovits in 1791.

Disinfection of Water

F. G. Novitskiy suggested the disinfection of water by hydrochloric acid with subsequent neutralization of the excess by soda. During the 1892-1893 cholera epidemic disinfection by hydrochloric acid was introduced among the troops by army order.

The use of concentrated hydrochloric acid to disinfect water has recently become popular again. Sodium bicarbonate at the rate of 5 g/l serves to neutralize the acid. Treatment with hydrochloric acid does not free water from viruses or *Entamoeba histolytica* cysts. Another shortcoming of the method is the formation of comparatively large amounts of sodium chloride. However, this is an advantage when the troops are on a march.

The first attempts at working out scientific methods of disinfecting water in the field for the Russian army were made in 1903 when the Scientific Committee for Military Medicine set up a special commission to select a method of purification. At the beginning of the Russo-Japanese War the Russian army had no safe ways of treating water. The results were not slow in coming, for "the use of low quality water in raw form was the main cause of dysentery, typhoid fever, and acute gastrointestinal inflammation." (The War with Japan, 1904-1905. A Sanitary-statistical Sketch.)

At the end of the war the army received from a medical supply house 320 large and 1,420 small kits "to purify and disinfect water chemically." These kits, put together according to the instructions of Professor Ye. A. Shepilevskiy, contained tablets made from a mixture of 1,312 mg of potassium bromide and 314.5 mg of sodium bromate (Na_2BrO_2). Under the influence of hydrochloric acid each tablet liberated 1,000 mg of free bromine, or enough to disinfect one pail of water in 15 minutes. The excess of bromine was bound by tablets made from a mixture of 1,575 mg of sodium thiosulfate (Na_2SO_3) and 880 mg of dry sodium carbonate.

The Shepilevskiy tablets simplified the task of determining the proportions of reagents and made the chemicals portable. This was the first time that chemicals were used in tablet form during a war.

The typhoid fever and cholera epidemics among the troops in World War I forced the commanders and heads of the medical service to turn to the disinfection of water chiefly by boiling. In 1915 chlorination was introduced first on the southeastern front, then in the other sectors. Somewhat later came field apparatus for chlorinating water and methods of test chlorination in three pails; dosages of chlorinated lime were established along with ways of determining residual active chlorine in water.

In 1915 D. A. Kamenskiy suggested the use of tablets consisting of one part chlorinated lime and four parts sodium chloride. Each tablet containing 1.2 mg of active chlorine was intended to disinfect one liter of water. According to official instructions, water treated with these tablets would after 20 to 30 minutes of contact be considered "safe and fit for drinking without any neutralization of the chlorine, the taste and odor of which disappears in disinfected water after this period of time elapses."

Experience during the war showed that chlorine tablets cannot be stored very long. There is an unusually rapid loss of active chlorine when the tablets are kept in a damp place. The slow solubility of the tablets is another serious obstacle to their use in the field.

The hope of solving the problem of disinfecting water with chlorine tablets led Soviet investigators to try to improve Kamenskiy's tablets, but they were unsuccessful. The findings of V. A. Uglov and his co-workers indicate that chlorine tablets dissolve slowly, lose their active chlorine quickly, and have no reliable bactericidal effect.

According to R. D. Gabovich, chlorine tablets lose from 36.8 to 60% of their active chlorine when stored for six months.

During World War II water was disinfected on a wide scale in all sectors of the front. Boiling and chlorination were the means. Chlorination of water right in the wells was very common. Quick and simple methods were developed. A more complex method of treating water was used at supply points: coagulation, chlorination, and filtration. Portable supplies were disinfected with "pantocide" [p-dichlorosulfamido benzoic acid] and hypochlorite tablets.

Purification of Water

The main task in purifying water in the field is disinfection or decontamination. Purification also improves the physico-chemical properties and taste of the water at the same time.

Depending on the indications, water is given the following types of treatment: (1) disinfection - destruction of pathogenic microorganisms; (2) decontamination - removal of poisonous substances; (3)

deactivation - removal of suspended and dissolved radioactive substances; (4) clarification -- disposal of admixtures causing turbidity; (5) decolorization - elimination of color; (6) deodorization - elimination of odors; (7) distillation - removal of salts or decreasing their concentration; (8) softening - reduction of hardness.

Water is disinfected by boiling or chlorination. If the enemy uses bacteriological weapons, boiling must continue for 10 minutes and at least one hour if there is a suspicion of infection by spore forms. Chlorinated lime is used for chlorination in the field. Water is disinfected by the method of rechlorination.

Water is clarified in the field by coagulation with subsequent settling or filtration through standard or improvised filters. Settling after coagulation requires a good deal of time -- at least two hours. Filtration of coagulated water makes it possible to reduce the treatment time considerably.

Coagulation with subsequent filtration renders water colorless and partly deodorizes it. Odor and aftertaste are removed by filtering water through activated or ordinary charcoal. The amount of the coagulant -- aluminum sulfate, iron sulfate with calcium hypochlorite or ferric chloride -- is determined by test coagulation in three pails.

Degasification and deactivation are done only at water supply stations using special filters and equipment.

Acrid water is distilled in POU apparatus with a capacity of 300 liters an hour and AFS and TUF-200 filters using ion-exchange masses: cationites and anionites. If the weather is suitable, water may be distilled by freezing.

Water is rarely softened -- only if it is intended for technical purposes or the laundering of linen.

Chlorination of Water

Chlorination is now the generally accepted method of disinfecting water in the field. Numerous attempts to replace chlorine with another chemical have been unsuccessful. For 50 years chlorine and its derivatives have been unsurpassed in effectiveness, availability, and ease of use.

The practical application of chlorinated lime in Russia began about the middle of the 19th century when P. Karachov published his book on the subject (1853). It became very common during World War I.

As the method grew in popularity, efforts were made in various countries to establish accurate dosages of chlorine to sterilize any kind of water. It was eventually demonstrated that a sufficient amount of chlorine had to be added to water to cover its chlorine requirements and ensure the presence of some residual chlorine for disinfection purposes. The advantages of leaving the residual chlorine in the water were so evident that attempts to establish a standard (universal) dosage were abandoned everywhere.

The investigators then tried, but unsuccessfully, to determine a standard dosage of residual chlorine to ensure disinfection under any conditions. Findings on the bactericidal properties of chlorine were often contradictory. The taste and odor of chlorinated water left much to be desired.

Hygienists discovered that the degree of chlorine absorbability (according to GOST [All-Union State Standard] 2915-45] representing total chlorine consumption depends on many factors: (1) presence of mineral salts in the water, particularly compounds of bivalent iron, manganese, and nitrites; (2) abnormal hardness and temperature of the water; (3) duration of contact of the water with the chlorine; (4) turbidity; (5) amount of chlorine added; (6) effect of light; (7) activity of the water; (8) nature of the organic compounds, and other things.

Chlorine solutions are rapidly hydrolyzed according to the following equation:

$$Cl_2 + H_2O \rightleftarrows HOCl + H^+ + Cl^-.$$

Consequently, water is not disinfected by the chlorine itself, but by its hydrolytic products, i.e., hypochlorous acid. This acid is formed by the addition of hypochlorites to the water, specifically calcium hypochlorite, as is shown by the following equation:

$$Ca\,(OCl)_2 + 2H_2O \rightleftarrows 2HOCl + Ca^{++} + 2OH^-.$$

Treating water with chloramines (pantocide) likewise results in the formation of hypochlorous acid, which is the principal disinfecting agent. HOCl is a weak acid dissociating according to the equation:

$$HOCl \rightleftarrows H^+ + OCl^-.$$

The pH of the water affects the course of the reaction. With a pH of 5 there is almost no dissociation, with a pH of 11 dissociation is complete.

The usual field method of determining chlorine absorbability is to ascertain the amount of residual chlorine in the water after 30 minutes of contact with the chemical. However, it must be borne in mind that the amount of residual chlorine may be affected by: (1) the most active hypochlorous acid and hypochlorite ions; (2) the least active chloramine, and (3) completely inactive "simulating" compounds -- nitrites, oxide compounds of iron and manganese, which displace iodine from potassium iodide and simulate the presence of residual chlorine. The influence of simulating compounds is readily eliminated after determining the residual chlorine by the iodine-starch method of acidifying the water with sulfuric acid.

Preliminary purification by settling, coagulation, or filtration (or by a combination of these methods) permits a more or less accurate determination of the chlorine requirements (chlorine absorbability) of the water. Clarification and decolorization of the water before it is chlorinated makes it possible to regard with greater assurance the conventional amount of residual chlorine as an indicator of reliable disinfection. It follows, therefore, that whenever circumstances permit, water should first be purified (by clarification and decolorization) and then chlorinated.

Later research has shown that the amounts of chlorine should be related to the nature of the pathogenic microflora in the water. For example, a concentration of active chlorine of at least 7.5 mg/1 is required to destroy the cysts of the dysentery amoeba. More chlorine is evidently necessitated by the thicker membranes of the cysts as compared with microbial cells.

The method of rechlorination or superchlorination makes it possible to reduce the time of disinfection to 10 or 15 minutes in the summer and 25 or 30 minutes in the winter. In the case of rechlorination the effective dose of chlorine (according to the chlorine requirements of the water) is not determined. Depending on the physical properties and color of the water and sanitary condition of the terrain adjacent to the source, chlorine is added at the rate of 5 to 20 mg/1. If the water is relatively clear, transparent, colorless, and away from polluted sources, 5 mg/1 of active chlorine is sufficient. Turbid water (with opalescence) more or less colored and in contact with a probable source of pollution requires that the amount of chlorine be increased to 10 or even 20 mg/1.

A great advantage of superchlorination is absence of the so-called drugstore odor of disinfected water. This unpleasant odor is often characteristic normally of chlorinated water due to the formation of chlorophenol. When water is treated with large amounts of chlorine, polychlorophenols are formed with barely perceptible odor and taste.

Superchlorination combined with dechlorination by activated carbon or charcoal markedly improves the physical properties of water, particularly its color.

Superchlorination is a fairly safe way of disinfecting water containing an abundance of ammonia compounds. Large doses of chlorine help to bind ammonia and its compounds while preserving an adequate amount of bactericidal active chlorine.

The above-mentioned advantages of superchlorination in ensuring safe and swift disinfection of water make it an exceptionally valuable method for use in the field when no purifying agents are available and it is impossible to apply laboratory controls over all stages in the treatment. It is of practical importance to be able to eliminate one of the processes -- determination of the effective dose of chlorine, which requires two to three hours.

The disinfection of water by normal chlorination (in accordance with its chlorine requirements) is feasible only when the water has good hygienic indicators and there is no danger that the enemy will use bacteriological weapons. In this event the water is treated with such amounts of chlorinated lime as will leave 0.3 to 0.5 mg/1 of residual chlorine after it is disinfected.

The amount of chlorinated lime required is ascertained by the method of test chlorination in three pails or three glasses.

If there is a threat that bacteriological weapons will be used, water is disinfected only by the superchlorination method with at least 100 mg/1 amounts of chlorinated lime while keeping the level of active chlorine above 25% (corresponding to 25 mg/1 of active chlorine). The time of exposure is 30 minutes.

If there is a suspicion that water is infected with spore forms, the amount of active chlorine is increased to 100 mg/1 (400 mg/1 of chlorinated lime). The time of exposure here is doubled.

The use of large amounts of chlorinated lime (from 25 mg/1 to 100 mg/1 of active chlorine) necessitates removal of the excess chlorine by dechlorination. Accordingly, it is recommended that the water be filtered through 30 cm of activated carbon or 50 cm of powdered charcoal. Chemical methods of dechlorination are rarely used in the field.

If disinfected water is to be stored for more than one day, it is chlorinated again so that the active chlorine amounts to 0.3 to 0.5 mg/1.

Disinfection of Water in Wells

During World War II wells were very commonly disinfected with solutions of chlorinated lime primarily due to the lack of standard and even improvised containers required to treat the water (cloth receptacles, pails, barrels, etc.).

The addition of a solution of chlorinated lime directly to wells practically assures the availability of disinfected water to the troops serviced by these wells. It excludes the possibility of using non-disinfected water from untreated wells.

The amount of chlorinated lime required to treat a well varies with the chlorine absorbability of the water and sanitary condition of the well itself. It must be remembered that pathogenic microflora, the causative agents of intestinal infections, remain viable for a long time in the silt at the bottom even when large amounts of chlorine are used. It is obvious, therefore, that the wells must be cleaned before they are chlorinated. Bacteriological research has shown that direct chlorination of wells is effective only when preceded by careful cleaning.

An important prerequisite to effective disinfection is measurement of the volume of water in a well and determination of its rate of exchange with the inflowing ground water. Accordingly, it is necessary

to measure the area of the water surface and depth of the column and to determine the reduction in level of residual chlorine both when the well is calm and when it is agitated.

Superchlorination is essential to ensure the safety of disinfected water in wells. The above-mentioned amounts of chlorinated lime (from 10 to 20 mg/l) are added for this purpose. After 20 to 30 minutes of contact the water is appraised organoleptically and then dechlorinated if it has an odor or aftertaste of chlorine.

Pantocide Tablets

During World War II the troops made extensive use of organic chloramines, which are outstanding for their high degree of effectiveness and stability following prolonged storage. One of the preparations in the group of organic chloramines (paradichlorosulfamido benzoic acid) known as pantocide was adopted by the Soviet Army as a water disinfectant in canteens. One pantocide tablet in a canteen disinfects the water in 30 minutes. Two tablets are used if the water is highly polluted.

Water treated with pantocide (one tablet per canteen) has a satisfactory taste. Two tablets impair the taste considerably. The main shortcoming of pantocide is that it takes 15 minutes or more to dissolve. Postwar observations have shown that water rich in organic substances is not effectively disinfected by pantocide.

These defects stimulated efforts to find other preparations to disinfect individual supplies of water. The research revealed the importance of the pH of the water.

Bisulfate Pantocide Tablets

The thorough investigations of M. A. Gubar' on disinfectants for individual supplies of water led him to prepare tablets containing two ingredients: sodium bisulfate and pantocide. Combining the two preparations in a single tablet is a sound idea because the bactericidal effect of chlorine increases in a weakly acid medium.

The bactericidal effect of bisulfate-pantocide tablets on water polluted with organic substances is also high, particularly when the water temperature is low. Zinc and iron containers proved to be unsuitable for use in disinfecting water by these tablets because of the solubility of iron and zinc in an acid medium. Their effectiveness is diminished when used in brick and concrete tanks.

Iodine Tablets

Repeated attempts have been made to use iodine as a disinfectant in the field. The French Army was supplied during World War I with iodine tablets containing a mixture of 0.1 g of potassium iodide and

0.0106 g of sodium iodide (Vayard). They proved to be of little value because of the need to add tartaric acid at the same time and then neutralize the residual iodine with sodium hyposulfite.

M. Obotova suggested iodine tablets consisting of iodine-organic compounds combined with tartaric acid. Iodine tablets dissolve readily (2 to 3 minutes), disinfect water satisfactorily, and are fairly stable in storage. The faint aftertaste of iodine completely disappears within 30 to 40 minutes.

According to S. S. Maksimenko and M. A. Gubar[7], the coli titer of polluted water treated with iodine tablets decreases markedly after 30 minutes of contact. Their bactericidal effect remains unchanged even at low water temperatures. Water can be treated with iodine in any but brick or concrete containers, which bind a considerable amount of iodine.

Coagulation of Water

Settling of water for the purpose of clarification was scarcely used during World War II chiefly because of the length of time required.

Natural settling is a relatively rapid method of freeing water only of large particles of sand and silt. It is used for 8 to 12 hours in the field for river water during the period of spring floods and fall rains. The presence of very fine particles of clay slows up the process to the point where it is not feasible. It is generally impossible to get rid of colloidal particles by settling.

The following coagulants are used for purifying water: aluminum sulfate [$Al_2(SO_4)_3$], ferrous sulfate ($FeSO_4$), ferric chloride ($FeCl_3$), etc. The first two are most commonly used in the field.

The coagulants interact with certain substances found in the water to form flakes which settle to the bottom. Due to their spongy structure and opposite charge the flakes attract and absorb dissolved and suspended organic substances in the water. The water becomes colorless and transparent and the number of microbes decreases 70 to 90%.

The coagulant most frequently used by the troops is aluminum sulfate — $Al_2(SO_4)_3 \cdot 18\ H_2$. According to all-union standards, the coagulant must contain 13.5% of aluminum oxide (Al_2O_3), which is its active ingredient.

Interacting with calcium and magnesium bicarbonates in the water, aluminum sulfate yields a colloidal solution of aluminum hydroxide according to the following equation:

$$Al_2\,(SO_4)_3 + 3Ca\,(HCO_3)_2 = 2Al\,(OH)_3 + 3CaSO_4 + 6CO_2$$

Fine, positively charged colloidal flakes of $Al(OH)_3$ attract and absorb negatively charged colloids in the water (humic substances, silicic acid compounds, etc.). The very fine flakes of $Al(OH)_3$ in turn absorb suspended bacteria and mud particles and draw them to the bottom. The small flakes gradually become larger and while settling

to the bottom free the water from mud, bacteria, and colloids. Coagulation thus clarifies and decolorizes the water.

Several factors affect the course of coagulation: composition of the water, content of calcium and potassium bicarbonates, water temperature, quantity and quality of the coagulant.

It is extremely important in the field to use the correct amount of coagulant. If the water is excessively alkaline, aluminum hydroxide forms soluble aluminates which do not precipitate. On the other hand, insufficient alkalinity and an excess of the coagulant form soluble complex compounds that pass through the filter and make the water turbid as a result of secondary coagulation.

If there is an insufficiency of bicarbonates, the water may be alkalized by soda — about 0.5 g of sodium carbonate (Na_2CO_3) per gram of aluminum sulfate. Slaked or unslaked lime may be used to alkalize water in the absence of soda or chlorinated lime, provided that the water is purified and disinfected at the same time. The Manual on Field Supply of Water to Troops recommends the addition of 0.25 g of unslaked lime, 0.35 g of slaked lime, or 0.5 g of chlorinated lime per gram of aluminum sulfate.

The coagulation process is affected by the quantity and quality of the colloids dissolved and suspended in the water. Turbid water is as a rule coagulated more readily than transparent or opalescent water. Coagulation can be accelerated by adding to the water clay, powdered carbon, or other substances that hasten the formation and precipitation of flakes.

Besides slaked and unslaked lime, clay, and powdered carbon, chalk and sodium silicate are used to improve coagulation. Clay, chalk, powdered carbon, etc., form nuclei of coagulation and hasten flocculation. Carbon, moreover, improves the quality of the water by absorbing substances that impart a foreign taste and odor. Chlorinated lime added before the coagulant prior to treatment disinfects the water and increases its alkalinity, i.e., it helps the coagulation process. Sodium silicate treated with sulfuric acid to decrease its alkalinity was successfully combined with a nepheline coagulant by T. I. Golubev during World War II.

Low water temperatures retard coagulation by slowing up flocculation. Therefore, it is necessary to introduce appropriate corrections when calculating the capacity of field installations for purifying water in the winter.

The required amounts of coagulant are determined after test coagulation in glasses or pails. A trial dose of aluminum sulfate is 100 to 300 mg/l. The smallest amount is selected that clarifies the water in the shortest period of time. In coagulating soft water the addition of lime (0.35 g per g of aluminum sulfate) or sodium carbonate (0.5 g per g of coagulant) may be required. Chlorinated lime is added if iron vitriol is the coagulant.

Iron sulfate ($FeSO_4$) and ferric chloride ($FeCl_3$) are used comparatively infrequently in the field to coagulate and dechlorinate water. Both chemicals are somewhat superior to aluminum sulfate, especially for clarifying and decolorizing water in wooded and swampy regions. Iron coagulants give better results in clarifying water in the winter when coagulation by aluminum sulfate is poor. Ferric hydroxide flakes [$Fe(OH)_3$] possess a higher specific weight; they settle to the bottom more rapidly and the clarification process proceeds much faster.

The coagulant is added to the water in dry form or in solution. One and five percent solutions of the coagulant are used to determine the amount. If it is impossible to weigh the desired dose of coagulant, it is measured off according to the figures shown in Table 16.

TABLE 16

Ingredients	Teaspoon, 3-4 ml capacity	Tablespoon, 20 ml capacity	Thick glass tumbler, 200 ml capacity
Aluminum sulfate, powdered	4-5	14-15	150-160
Iron vitriol, powdered	4-5	14-15	150-160
Slaked lime	3-4	12-15	120-125
Sodium carbonate	6-7	19-20	200-210
Chlorinated lime	2.5-3	9-10	about 100

If the test coagulation is poor, the amount of coagulant is increased to 400 to 500 mg/l; in case of failure, slaked lime or soda is added to the water according to Table 17.

TABLE 17

Amount of alumina		It is necessary to add			
		slaked lime		sodium carbonate	
mg/l, g/m³	1% solution ml/l, l/m³	mg/l, g/m³	1% solution ml/l, l/m³	ml/l, g/m³	1% solution ml/l, l/m³
100	10	35	3.5	50	5
200	20	70	7.0	100	10
300	30	105	10.5	150	15
400	40	140	14.0	200	20
500	50	175	17.5	250	25

If iron vitriol is used as a coagulant, chlorinated lime is added to the water in the proportion mentioned in Table 18.

TABLE 18

Amount of iron vitriol mg/l or g/m^3	Amount of chlorinated lime in g with an active chlorine content 20%	25%
50	130	105
100	165	132
200	230	182
300	290	233
400	355	285
500	420	336

The amounts of iron vitriol and chlorinated lime are determined by test coagulation. Chlorinated lime is added to the water 15 to 20 minutes before the iron vitriol. If coagulation is poor and the water has a weak chlorine odor, 1 ml/l of 1% solution of chlorinated lime is added. In the absence of filters the water is allowed to stand two to four hours after coagulation.

The coagulant and chlorinated lime are introduced into the water at the same time. The amounts are also selected simultaneously (Manual on Field Supply of Water to Troops).

Five minutes after introducing iron vitriol, 0.5 g/l of powdered charcoal or 0.2 g/l of activated carbon may be added for better clarification, decolorization, and dechlorination. The water is filtered 5 to 10 minutes later.

According to N. N. Klyukanov, the disporportion between iron vitriol and chlorine inevitable in the field may be overcome by "coaling" the water. This helps greatly in determining the correct proportion between the iron coagulant and chlorinated lime. By "coaling" is meant the process of treating water with powdered carbon to dechlorinate, deodorize, and decolorize it. Activated carbon and carbon obtained by burning ordinary wood fuel are equally suitable. The sorption capacity of ordinary carbon is one half or one third that of peat charcoal. The finer the powdered carbon, the greater its sorption properties. According to Klyukanov, the chlorination of water containing 10 mg/l of residual chlorine requires 0.2 g/l of pulverized activated carbon or 0.5 g/l of ordinary carbon. The residual chlorine must be in contact with the powdered carbon 5 to 10 minutes.

Filtration of Water

Water is filtered in the field by means of standard facilities and filters made from locally available materials. The characteristics of Soviet Army equipment are presented in Table 19.

TABLE 19

Type of filter	Capacity in liters per hour	Weight in kg	Duration of operation, in hours: without flushing	before running down	on the available supply of expendable materials	Time to obtain purified (potable) water, in min	No of service personnel
Universal portable filter UNF-30, 1942 model	30	5-6	—	21	6	3-4	1
Universal portable filter UNF-30, 1940 model	15-20	8	—	21	4	3-5	1
Cloth-carbon filter TUF-200	300-400	80	4-6	30-40	100	40-60	2
Truck filter plant AFS-5000	2500-5000	—	6-8	—	300-500	50-70	4

Truck filter plant AFS and cloth-carbon filter TUF-200, which are designed for all types of water treatment except distillation, are ordinarily used in setting up water supply points.

Universal portable filter UNF 1940 model with a capacity of 20 liters an hour and UNF 1942 model with a capacity of 30 liters an hour are designed to supply water to small units.

Operation time of a filter without changing the chemical reagents: for poisoned water - 4 hours, for non-poisoned water - 12 to 16 hours. In treating water the hose of a suction pump is dropped into the stream or reservoir and the water is drawn through the first and then the second columns and leaf filter. The water is thus decontaminated and disinfected. If poison gas is present, the carbon filters are replaced after two hours of operation of the UNF-30-1; the used filters are buried in the ground. If there is no poison gas, the filters are replaced after six to eight hours.

The UNF-30-20 device has no leaf filter. It uses pantocide tablets (400 capacity) to disinfect the water.

To clarify and disinfect water with a TUF-200 device (Figure 32), the filter is loaded with activated carbon. The device consists of three sedimentation tanks filled with water from canvas pails. A coagulant and chlorinated lime are added to the tanks at the same time along with soda or lime to alkalize the water, if there are indications therefor. An hour after the reagents are added, the water is pumped from the tank into a cloth filter for clarification and dechlorination by activated carbon. If the water is to be kept for more than one day, a solution of chlorinated lime is added at the rate of 0.3 to 0.5 mg/1 of active chlorine.

After four to six hours of continuous operation the cloth filter is replaced with a fresh one. The activated carbon is replaced as soon as the filtrate is found to have an odor of chlorine.

Adding one fourth of the tank may increase the capacity of the TUF-200 to 250 to 270 liters an hour.

A truck filter plant is capable of treating water in various ways: filtration, chlorination, filtration with preliminary coagulation, decontamination, deactivation, and complete purification.

The setting up of an AFS as part of a water supply point is diagrammed in Figure 33. If the water has to be clarified and disinfected, the filters are filled with pulverized anthracite and activated carbon (for dechlorination).

Water is drawn from the source by a pump M-600 into sedimentation tanks to which a coagulant and chlorinated lime are added. If the water needs to be alkalized, slaked lime or soda are introduced at the same time as the coagulant or a little before. An hour later the water is pumped over to the first filter for clarification and then to the second filter for dechlorination.

During World War II water was commonly treated with the help of improvised filters made of locally available materials. The most effective under field conditions were cloth filters of different design and capacity. Tent cloth, cotton serge, and other closely woven materials were used as filters.

The filters were packed with locally prepared charcoal for which red hot coals were poured into vessels with water. The water was removed and the wet coals pulverized, dried, and the dust drawn off. Ordinary sand or cloth filters were used to clarify colorless water and to disinfect it with normal amounts of chlorine. Cloth-carbon and sand-carbon filters (Figures 34 and 35) were employed for water requiring decolorization and removal of excess chlorine, i.e., dechlorination. The capacity of the filter per m^2 of cross section was 1 to 1.5 m^3/hour. The capacity was doubled if the water was first coagulated and then allowed to settle.

The best results were obtained when the water was first coagulated by aluminum sulfate or treated by the chlorine-vitriol method. In either case a film of aluminum hydroxide or ferric hydroxide formed on the cloth filter and helped the process of purification, clarification, and

decolorization of the water. If there was no preliminary coagulation, the film formed quite some time later from particles suspended in the water.

Filters made out of locally available materials may be used instead of standard equipment. Sand, pulverized anthracite, activated carbon or charcoal, etc., may be used as a filtering medium. The sand is packed down in a layer 50 cm thick, the particles measuring preferably 0.5 to 1 mm. The capacity of 1 m^2 of filter area is 500 to 1,000 liters an hour. The water is coagulated and allowed to stand before it is filtered.

Filter wells or filter trenches are often used in the field to supply water (Figures 36 and 37). One or more wells are dug alongside a lake or river, the water level being 1 m below that of the stream. The water passes through 15 to 20 m of earth and enters the well filtered and clarified. If the stream is infected, the distance is increased to 30 to 50 m. The output of such wells is very high if the earth is well drained. The water thus filtered requires disinfection.

If the soil is not well drained, the well is dug 3 to 5 m from the river bank and connected to it by a filter trench filled with gravel, sand, and charcoal. The bottom of the trench must always be 1 m below the level of the water in the stream.

Decontamination of Water

If radioactive substances are present in the water, it may have to be decontaminated. The intensity of contamination will vary with the size of the atom bomb or shell, height of the blast above the ground, and distance of the source of water from the epicenter of the blast. The size of the body of water, depth, presence or absence of a current, and salt composition will also be very significant. The existence and kind (reliability) of shielding (shelters) is another important factor in determining the degree of radiocontamination.

The terrain, presence or absence of woods, time of year, and weather conditions (force and direction of the wind, precipitation) are also highly important.

If radioactive substances are found in amounts exceeding the permissible limits, the water may not be used for drinking, cooking, or sanitary needs. It is decontaminated only if there is no other potable water available for the troops (from bore and shaft wells or that could be trucked in).

Decontamination involves: (1) distillation; (2) processing in ion-exchange filters; (3) filtration through carboferrogel with preliminary coagulation; (4) purification by coagulation and filtration.

Distillation is done on a limited scale due to the cost and relatively low capacity of the portable distiller (PDU), which does not exceed 300 liters an hour (Figure 38).

It must be kept in mind that water discharged from a heat exchanger contains radioactive substances and is therefore dangerous to man and animals.

The ion-exchange method of decontaminating water is the most suitable under field conditions.

Ionites are high-molecular compounds possessing the properties of acids and bases. The presence of acid or base groups in ionites enables them to be absorbed from solutions, to concentrate and hold on their surface a great variety of substances. This property of ionites -- the ability to undergo ion-exchange reactions -- explains their name "ion-exchange resins."

Ion-exchange resins are of two kinds: cation-exchange - cationites, and anion-exchange - anionites. The former extract all the cations (Ca, Mg, Na, etc.) from the water while the latter extract all the anions (sulfates, chlorides, etc.). Consequently, water can be freed from its ions by successively processing it in two filters loaded with cationites and anionites.

Water is usually decontaminated by passage through a layer of cationites and then through a layer of anionites. Sulfitized carbon particles from 0.25 to 1 10 mm in size are used as cationites, which are obtained by processing pulverized coal with sulfuric acid.

Water is distilled while being processed in ion-exchange filters because the ions of radioactive substances as well as the ions of salts dissolved in the water are involved in the ion exchange. That is why the output of the filter is markedly reduced when highly mineralized water is treated in an ion-exchange filter. Hence, fresh or already coagulated water must be added to the ionites. In addition, the decontamination process requires the water to be clarified because the ionites cannot take the place of a filter and the turbid particles may contain radioactive substances.

Standard water purifiers (TUF-200 and AFS-5000) and filters made from materials at hand may be used to decontaminate water by the ion-exchange method (Figures 39 and 40).

Water may be decontaminated by filtering it through a layer of carboferrogel after preliminary coagulation. The radioactive substances are caught by the flocs of the coagulant and absorbed by the carbo-ferrogel (Figure 40).

If two TUF-200 are available, water can be degassed and decontaminated in turn. The first TUF-200 is filled with cationites, the second with anionites. The capacity of both filters is then 100 to 150 liters an hour, but they operate (before reloading) almost twice as long.

The method of decontaminating water with an AFS-5000 using cationites is shown in Figure 41.

Decontamination of water by treating it with carboferrogel after coagulation and settling is illustrated in Figure 42.

The filter can be loaded with carboferrogel (about 200 kg) instead of crushed anthracite. Instead of activated carbon, cationites can be used in the dechlorinators (about 400 kg in both housings).

Water treated this way is clarified, disinfected, degassed, and decontaminated. The water is first pumped into sedimentation tanks for chlorination. Another pump then forces it to the filters. If there are appropriate indications, the water is coagulated and allowed to settle.

Personnel in charge of the AFS and TUF-200 must strictly observe the regulations for radiation safety. They may work only when wearing protective clothing.

When using locally available materials, the water is passed through a layer of carboferrogel-M at least 40 cm thick. The output of a non standard-type filter should not be more than 0.1 liter an hour per cm^2 (Figure 43).

Water may be partially decontaminated by coagulation followed by settling and filtration through standard or improvised equipment. Carbon (ordinary or activated), sand, anthracite (crushed), etc., may be used as filters. The radioactivity of the water is reduced about 60 to 70%. The output of filters used this way is not more than 0.3 liter an hour per cm^2 (V. I. Buzykin and N. D. Shuvayev).

Since suspended substances (clay particles, microscopic organisms, etc.) are carriers of radioactivity, the water must be clarified. It is also possible to add a fine suspension of clay to decontaminate it. This clay, of course, has to be filtered out later.

It has been proved experimentally that the addition of 1 g/l of various kinds of clay to water reduces its specific radioactivity 50 to 90%.

There are grounds for believing that iron coagulants are more effective than aluminum sulfate because ferric hydroxide ($Fe(OH)_3$) produces thicker and heavier flocs that quickly settle to the bottom of the tank. Its sorption capacity is also higher than that of $Al(OH)_3$; moreover, it is helpful in freeing the water from arsenic compounds.

Personnel engaged in decontaminating water must be carefully instructed on the injury that may be caused by the penetration of radioisotopes into the organism. While working they must wear protective clothing, rubber shoes and gloves. It is absolutely forbidden to smoke, drink water, or eat during this time. The level of irradiation in work places is determined with the aid of dosimeters. Very active equipment and receptacles must be decontaminated.

The help of physicians is required in connection with the disposal and decontamination of filtering material, radioactive wastes, and incrustation formed on the sides of the evaporator and POU pipes.

The filter inevitably becomes contaminated as a result of the filtration of water containing radioactive material in suspension. Hence, the used filter must be buried in the ground in accordance

with established safeguards. The place of burial must be chosen beforehand and be far away from sources of water and thoroughfares. It is well to line the sides and bottom of the pit with soft clay. It is important that the site not be washed out by flash floods and thaw water.

Despite the difficulties involved in organizing water supplies should atomic weapons be used, the problem should not be exaggerated. Lakes and rivers cannot be regarded as primary objects of attack. As regards radioactive infection of ground waters, this is hardly a serious danger because the sorption and ion-exchange properties of the soil are very high. Consequently, radioactive substances will be concentrated in the upper layer of the soil to a depth of several centimeters. There is every reason for believing that a shaft well and, in particular, a tubular well dug in a contaminated area will yield pure water.

The major problem is to prevent radioactive matter from seeping down into the well, which is done by constructing a clay seal and digging drainage ditches.

Field methods of purifying water (coagulation, sedimentation, and filtration) permit the removal of most of the radioactive contaminants. Coagulation is the principal method. The effectiveness of purification varies with the kind and form of radioisotopes as well as the coagulants used. Simple mechanical filters mechanically trap the suspended particles containing radioactive matter. Special filtering material like carboferrogel-M absorb radioactive compounds soluble in water.

In a war the main problem will be to remove from water the products of uranium fission, especially strontium-90. Experience has shown that when strontium is removed, the water is freed from most of the uranium fission products.

It has been shown experimentally that the maximum amount of strontium is removed (about 84%) by ordinary coagulation after preliminary alkalization with soda lime. Some 95% can be removed if calcium phosphate is substituted for aluminate sulfate. At the same time the water is freed from barium and rare earths. Other methods of purification are required to eliminate ruthenium and cesium. Addition to the water of glauconitic clay and montmorillonite possessing exchange properties followed by coagulation has yielded good results.

According to R. Lauderdale, the addition of clay plus the use of calcium phosphate as a coagulant can remove up to 99% of the uranium fission products (strontium, barium, rare earth elements), including a good deal of ruthenium and cesium.

Degasification of Water

During war the sources of water are exposed to the danger of contamination by toxic chemical agents, which may be spread by airplanes (through spraying or dusting, chemical bombs) and by artillery or mortar fire. Only wells, ponds, small lakes, and cisterns can be seriously contaminated in this way. It is extremely difficult to contaminate large lakes, rivers, and reservoirs because most of the presently known poisons are not readily soluble in water and it is virtually impossible to create a toxic concentration.

The possibility of chemical contamination of water is determined chiefly by the type of agent and its properties. For example, poisons in gaseous or vapor form cannot affect water. Poisonous fumes (diphenylaminochloroarsine, diphenylcyanarsine) can contaminate water if applied long enough and in sufficiently high concentration. A greater danger comes from the blister gases (mustard gas, trichlorotriethylamine, lewisite, methyl dichloroarsine, ethyl dichloroarsine). Diphosgene and hydrocyanic acid can also contaminate water.

In degassing water one must keep in mind the phenomenon of hydrolysis. For example, phosgene and diphosgene react swiftly with water. The resultant non-toxic products are rather quickly and completely neutralized by alkalis present in the water.

The situation is different with the group of arsenicals (lewisite, methyl dichloroarsine, ethyl dichloroarsine), which yield poisonous products as a result of hydrolysis. Lewisite has a solubility in water of 0.2 to 0.5 g/l (S. Maksimenko). Adamsite and diphenyl chloroarsine do not dissolve in water. Mustard gas is hydrolyzed to non-toxic products if the water is sufficiently alkaline and the hydrolytic process is protracted. The solubility of mustard gas at ordinary temperatures does not exceed 0.5 to 0.8 g/l (S. Maksimenko). As the water temperature rises, its solubility increases along with the rate of hydrolysis.

Hydrolysis can be hastened by chemical treatment. For example, alkalization is recommended to accelerate the reaction of cyanogen chloride with water. According to D. Sanchez, if the alkalinity is low, about 4 mg/l of soda is added per mg/l of cyanogen chloride (CNCl). Under these circumstances the hydrolysis of cyanogen chloride produces a fairly harmless cyanate. If the concentration of cyanogen chloride exceeds 100 mg/l, the water becomes unusable after hydrolysis according to organoleptic data.

Other cyanides, particularly hydrocyanic acid, readily dissolve in water while retaining their toxicity.

Hydrolysis of certain poisons may be hastened by heating the water. This method is used only if the toxic agents do not yield poisonous hydrolytic products or if the latter have no effect on the organoleptic properties of the water.

Good results are obtained by treating water containing toxic agents with activated carbon. This method has the merit of removing the odor and taste of the hydrolytic products of mustard gas formed in the water. Less effective is the use of activated carbon to treat water containing the hydrolytic products of trichlorotriethylamine (nitrous mustard gas).

According to Sanchez, about 30 mg/l of activated carbon are required per liter of water containing 1 mg of mustard gas or thiodiglycol. The amount of activated carbon is tripled for partically hydrolized trichlorotriethylamine. The water and powdered carbon must be in contact at least 30 minutes. The suspension of contaminated carbon is removed from the water by sedimentation, coagulation, or filtration.

Chlorination is used to remove the products of mustard gas hydrolysis from water. This procedure is ineffectual in the absence of non-hydrolyzed mustard gas. It must be borne in mind that the binding of chlorine by thiodiglycol takes place slowly so that one may get a false notion about the harmlessness of water from the presence of residual chlorine. Sanchez recommends chlorination with 1 mg of chlorine per liter of water containing 1 mg of thiodiglycol. Lewisite reacts quickly in water, forming vinyl chloride, which is less toxic than lewisite. However, it is very difficult to remove vinyl chloride from water. The reaction of trichlorotriethylamine with chlorine in water takes place very slowly.

Thus, if vesicatory agents are in water, they must be removed before chlorination. It is practically impossible to free water from hydrocyanic acid and cyanogen chloride by chlorination.

The high tension of hydrocyanic acid and cyanogen chloride fumes at ordinary temperatures is the reason why water can be degassed by aeration. Vigorous aeration by spraying water about or passing air through it removes the cyanogen chloride as well as the unpleasant aftertaste and odor. Aeration is insufficient to free water from even moderate amounts of hydrocyanic acid. Since the chlorination of water containing hydrocyanic acid results in the production of cyanogen chloride, Sanchez recommends that the water be chlorinated first and then aerated. 2.7 mg/l of chlorine is required to convert 1 mg of hydrocyanic acid into cyanogen chloride. Within 60 minutes of vigorous aeration the cyanogen chloride produced by chlorination disappears. Water thus treated, in the author's view, is safe and satisfactory to the taste.

Distillation frees water from mustard gas, trichlorotriethylamine, and lewisite. The unpleasant odor of the distillate may be removed by activated carbon. Distillation is useless for degassing water if it contains cyanogen chloride and hydrocyanic acid.

Alkalization followed by boiling hastens the hydrolysis of vesicatory poisons. It must be remembered that hydrolysis does not overcome the toxicity of vesicants containing arsenic.

Five minutes of boiling in an open vessel are enough to free the water from cyanogen chloride. S. Maksimenko recommends that the water be first acidified by hydrochloric, sulfuric, or acetic acid to a pH of no more than 4. It is essential to avoid inhaling the vapor of the heated water. Sanchez regards degasification of water by boiling as useless if it contains hydrocyanic acid and its compounds in a concentration of over 200 mg/l.

Coagulation followed by sedimentation and filtration is used to remove suspended substances: the products of combustion of incendiary substances and smoke pots, toxic vapors, and droplets of vesicatory poisons.

If the water is severely contaminated, special technical degassing procedures may be carried out by the engineer service.

Supervision of the completeness of water degasification in the Soviet Army is a responsibility of the medical service.

Distillation of Water

Salt and acrid water unfit for drinking and cooking is often encountered in certain regions of the Soviet Union. This makes it necessary to resort to desalinization by physical or chemical means.

The thermal method is the safest for use among troops. Boiling is followed by condensation of vapor in a condenser. The diagram of a portable purifier is shown in Figure 38. The POU apparatus widely used by the Soviet Army produces 300 liters of fresh water an hour.

Turbid water is allowed to settle before distillation and, if necessary, coagulated. Water obtained from a distiller does not need to be disinfected or decontaminated. The taste may be improved by adding a little of the original salt water. This also enriches the water with microelements present in salt water, but not in distilled water.

Soviet Army engineer headquarters prepared and sent to the troops back in 1942 "Instructions on the Distillation of Water by Freezing." Freezing water for the purpose of distillation is possible when the outdoor temperature is 3 to 4° below zero for at least five hours a day. The principle is that fresh water freezes at 0° while salt water freezes at lower temperatures depending on the degree of salinity. Consequently, when salt water is chilled, the fresh water freezes first and forms fresh ice leaving the salt water underneath. The degree of salinity will increase as the fresh ice congeals because the salt steadily becomes more concentrated.

Experience has shown that salt particles are frozen into the fresh ice so that it is salty to the taste. It is recommended, therefore, that fresh ice obtained by freezing be allowed to thaw slowly at 3 to 5° above zero. Salt water is thus produced first and removed during the slow thawing. The ice left after removal of the salt water yields virtually fresh water that is suitable for drinking and cooking.

If the water is very salty, it is impossible to obtain enough fresh ice at one time. Too much salt water is produced when the ice is thawed slowly. Hence, this incompletely freshened water must be refrozen and slowly thawed again. The usual result is fairly fresh water. However, if it is still too salty, the freezing and thawing is repeated once more.

Experience indicates that to produce a layer of ice 2 to 2.5 cm thick on salt water 4 to 4.5 hours are required at an air temperature of -5°, 2 to 2.5 hours at -10°, and 1.5 to 1.75 hours at -15°.

Any kind of receptacle (barrel, box, cloth tank, boat, etc.) may be used to freshen water by freezing. If the water requirement is in excess of 100 to 200 liters a day, shallow basins are dug in the ground or tanks sturdily put together from boards and caulked. They are 20 to 25 cm deep and no more than 2.5 m wide.

The freezing of water, storage, shipment, and thawing of ice must be done in such a way as to prevent pollution of the tanks, transport facilities, ice, and water. The water supply point set up for distilling water by freezing must be surrounded by a sanitary protective zone where unauthorized persons may not enter and all activity is prohibited that is conducive to pollution of the area, water tanks, and ice.

The feldsher or sanitary instructor is responsible for inspecting the sanitary condition of the water supply point area and seeing to it that the regulations for distilling water are observed.

Ion-exchange resins have recently and successfully been used for distilling acrid water.

Production of Water from Ice

In the Far East sometimes the only source of water is fresh-water ice because the lakes and rivers are often frozen to the bottom. Under these circumstances a piece of land is set aside to store ice at least 200 m from sources of pollution.

A sanitary protective zone with a radius of no less than 100 m is set up around the area. The preparation, storage, and shipment of ice are carried out in strict conformity with the regulations governing the shipment and storage of disinfected water. The ice is transported in special covered boxes to the place where the water is to be prepared. The tools employed (crowbars, axes, or shovels) may not be used for any other purpose. The ice is stored only in restricted places fenced off by snow, ice, or barbed wire.

The ice is thawed in special boilers. The water obtained from the ice may be used in raw form only if the ice comes from remote streams unpolluted by man or animals. Otherwise, disinfection of the water by boiling or chlorination is indicated.

All personnel engaged in this work receive a careful physical checkup and are kept under continuous medical observation. The requirements are the same as for the men working in mess halls and kitchens.

About 0.1 m^3 of water is obtained from one cubic meter of loose snow; 1 m^3 of old, well-packed snow yields from 0.2 to 0.25 m^3 of water.

Water from snow or ice lacking mineral salts must, if it is to be used for any length of time, be supplied with 0.2 to 0.3 g of slaked lime and 0.1 g of table salt per pail.

Organizing the Supply of Water for Troops in the Field

If the water supply is well organized, the troops should receive adequate quantities of good water with no interruptions. Water needed for drinking, cooking, and housekeeping needs is estimated in relation to combat circumstances according to the rate of water consumption.

The following steps are taken to supply troops with water during wartime: reconnaissance of sources, setting up of supply points, organization of distribution, transportation and storage, and medical control of quality.

In regions with abundant water, supply points are set up in the various units. This makes it easier to deliver water to the consumers, shortens the time of transportation, and saves on transport facilities.

In arid regions and in the permafrost zone and if there is a threat of radioactive, chemical, or bacterial infection of the area, it is desirable to establish high-capacity supply centers with distribution points in large and small units.

Special personnel — combat engineers — are assigned to set up supply and distribution points.

The resources of battalions and smaller units are used to deliver water for drinking and housekeeping purposes. Transport of water from regimental and division supply points to distribution points is organized in accordance with instructions of the chief of the division or unit service troops.

In arid regions and in places lacking suitable sources of water in the rear, transport of water to distribution points is organized in accordance with instructions of the higher service elements.

Special sources of water are set aside for bakeries, baths, and laundries.

Reserve points are established against possible destruction of the regular supplies or poisoning or infection of the sources.

All cases of infection and contamination of water by radioactive substances or toxic chemical agents or bacteria must be promptly brought to the attention of the commanders of divisions and smaller units, chemical service chiefs, engineers, and medical personnel.

Medical personnel have the following duties in connection with supplying troops with water in war: (1) participation in sanitary reconnaissance and inspection of water sources; (2) hygienic appraisal of water and determination of its safety; (3) participation in selecting methods of degasification, decontamination, and disinfection of water; (4) observation of water treatment processes; (5) evaluation of potability

of degassed and disinfected water; (6) authorizing the use of water for drinking, food preparation, sanitary and housekeeping needs; (7) participation in measures designed to protect the sources of water and reserve supplies from infection; (8) inspection of the disposal, degasification, and decontamination of dangerously unhealthy sewage (after rinsing filters and receptacles) and filtering materials (sorbents).

Medical personnel work in close cooperation with engineering and chemical personnel. They obtain from the commanding officer timely information on the possibility of enemy use of atomic, chemical, or bacteriological weapons. Medical personnel are guided by military and civilian laboratories and at the same time make use of portable indicators and dosimeters.

Increasing signs of deliberate infection and contamination of the water by the enemy requires that the medical service concentrate on organizing water supplies for troops in battle. The unit senior medical officer (division surgeon) together with the commander of the combat engineer platoon (battalion) determine the place and time for setting up regimental and division supply points. Orders to the regiment (division) must strictly forbid the use of water other than from these supply points. If the enemy employs bacteriological weapons, the drinking water is boiled. The canteens, boilers, and portable containers of all large and small units are filled with boiled water immediately after an attack. If there are delays in supplying boiled water, the feldshers and sanitary instructors are issued tablets to disinfect water right in the canteens.

Since the water may not be safely disinfected due to ignorance, company sanitary instructors supervise the use of the tablets. Canteens are filled with water from artesian wells, which are less likely to be polluted, or from large lakes or rivers that are hard to infect. Sanitary reconnaissance of sources of water is carried out immediately after occupying enemy territory.

Water Supply Points. Water supply points are organized to provide troops with the necessary amount of water for drinking, cooking, hygienic and housekeeping purposes. These are specially equipped areas for obtaining, purifying, disinfecting, decontaminating, deactivating, and degassing water.

The main elements of a major supply point are: source of water, apparatus to improve, degas, and decontaminate it; storage tanks; place to wash receptacles; transport center for hauling water.

The points are set up in companies, battalions, regiments, and divisions. They must be close to the source of water -- river, lake, spring, tubular or fairly large shaft well.

Water supply points are set up chiefly around bore and shaft wells or springs. If there are no such sources or the available water is of low quality, new wells, tubular or shaft, are dug at these points. Special-purpose points are set up at streams or lakes (for washing up, sanitary treatment, servicing and washing of automobiles, etc.). The water supply points alongside a river are located upstream; a little below are places for swimming, watering of cattle, cleaning of horses, then laundering of linen, and washing of automobiles. The special treatment points must be at least 0.5 km away from the supply points and other places where water is used.

In setting up a water supply point the data obtained from sanitary reconnaissance must be taken into consideration along with camouflage considerations. It is also necessary to protect the source from contamination by poison gas, radioactive substances, and bacterial preparations and to provide shelters for the service personnel.

Regimental and division water supply points have: (1) a work area for collecting, treating, and storing the water; (2) a shelter for personnel and equipment; (3) a transport center; (4) an area for cleaning, washing, and disinfecting receptacles and canteens; (5) a storage place for materials and supplies; (6) a control center; (7) a place for a laboratory; (8) an observation post equipped with means of chemical and radiation reconnaissance.

Roads are built to the points and the adjacent land fenced off and guarded.

Company and battalion points are simpler. They have a source of water with lifting equipment and areas for treatment, storage, delivery of water and shelter.

If water is contaminated during a war by gas or radioactive substances, the area for treating the water (degasification and decontamination) is organized to meet the special requirements of these procedures. There is a separate place for degassing and decontaminating receptacles.

Particular attention is paid to the removal and burial of filtering material after degasification and decontamination because it may contain a substantial amount of gas or radioactive substances. The waste water is led off into filter (non-absorbing) pits dug some distance away from the work areas.

Company and battalion points are usually set up at shaft wells whose capacity is 4 to 8 m^3 of water a day. The capacity of small tubular wells (MTK-2) is 10 m^3 a day, with a potential hourly rate of 1 m^3. Shaft wells about 25 m deep are usually dug for regimental points. Their capacity is about 10 m^3 an hour. The water is brought up by a compartmental belt hoist.

A bore well may be used in establishing a division water supply point. The daily capacity depends on the size of the pump. With a power pump it reaches 60 to 140 m^3 a day. The use of an immersible electric pump raises the capacity to 150 m^3 or more a day. Water supply points of this kind are also set up to supply rear installations (field hospitals, bakeries, meat-packing plants, etc.).

In setting up a supply point provision is made for the operation of water purifying and disinfecting apparatus. These include a truck filter plant (with a capacity of 150 m^3 a day), cloth-carbon filters of the TUF-200 type (with an hourly capacity of 200 liters), and other filters made from locally available materials. Figure 44 shows the layout of a major water supply point using an AFS-5000.

The primary treatment, storage, and discharge of polluted water takes place on the dirty area of the supply point. A pit and drainage ditch for the waste water are dug here next to the tank and pump. The AFS is installed in another area. A third area is used to collect and store the disinfected, decontaminated, and detoxified water. This is where radiation is monitored.

The use of authorized materials for degassing and decontaminating water decreases the output by half.

Two BKF-4 hand pumps with three RE-6000 sedimentation tanks can treat 2 m^3 of water an hour. This kind of installation is usually intended for a regiment.

If there are no standard filters available and it is impossible to make them from materials at hand, lake and river water is disinfected simply by coagulation, chlorination, and sedimentation for one to two hour The water is then passed through filters made from materials at hand.

Water supply points lacking standard equipment can only handle the disinfection of water. Degasification and decontamination are not performed there.

During hostilities in the mountains water supply points are best set up at springs after capping the source. Depending on the flow of the spring, the capacity of the supply point may amount to tens of cubic meters of water an hour.

Water supply points in desert terrain where the water is acrid are provided with portable distilling apparatus, which have a capacity of 5 to 6 m^3 of water a day. If the water requires decontamination, the layout of the point and its capacity are unchanged. Special attention here is focussed on disposal of the concentrate containing radioactive compounds far from the supply point.

If no sources are available, supply points are set up and water is brought in by trucks or pipes. RE-6000 tanks, BKF-4 pumps, M-600 motor pumps, and other items for storing and pumping water are installed at distribution points. During cold weather the tanks and pumps are heated.

Major water supply points located near open water have observation posts equipped with devices for detecting chemical and radiation activity. Sometimes there are chemical observation posts. Their task is to observe enemy activity, engage in chemical and radiation reconnaissance within a radius of 500 to 1,000 m, and warn of zones of infection.

A sanitary protective zone is established to prevent pollution of a source of water within a radius of 50 to 100 m. Only authorized personnel are allowed to enter the work area of the supply point.

Sanitary supervision by medical officers includes: (1) organoleptic and laboratory appraisal of the water; (2) systematic observation of the results of purifying, disinfecting, detoxifying, and decontaminating the water; (3) periodic laboratory control of the quality of the water; (4) determination of the limits and operating conditions of the sanitary protective zone.

Responsibility for the performance of these tasks in a military region rests with the commanding officer of the medical unit; in army and front areas it rests with the hygienic divisions of laboratories.

Sanitary control of the quality of water at supply points for large and small units is exercised by the physician of the corresponding unit.

The physician assigned to a water supply point observes the health of the service personnel, who are examined every 10 days and checked every other month to see if they are carrying bacilli. Those found to be suffering from an acute intestinal disease or who are carrying bacilli are promptly taken off the job.

Water Supply for Troops on the Offensive. According to the Manual on Field Supply of Water, troops on the offensive obtain water by: (1) using captured supplies; (2) transporting water from previous equipped supply points, and (3) setting up new points in positions captured by attacking troops, on transportation and evacuation routes, and at new locations of rear installations (hospitals, etc.).

In getting ready for an attack, water supply points are set up in troop concentration areas (one for each battalion and separately for aid stations) while transport facilities are prepared to supply water to the troops before new points are established in occupied territory. It is particularly important that standard and improvised equipment and receptacles be made ready in advance.

Canteens are filled with good water (boiled rather than chlorinated) just before an attack. All portable receptacles, including boilers, are also filled with drinking water (at the rate of 2 liters per man).

During the offensive supply points are set up in such a way that the troops have an uninterrupted supply of water in accordance with established norms.

In arid regions, besides supply points, distribution points are set up with reserves brought in by railroad, truck, and plane.

Before an attack sufficient water is stored at the supply and distribution points to meet the requirements for a day or half a day.

If fresh water is limited, supply points are set up at sources with salt water, which has to be distilled.

The supply points shift with the advancing forces. Existing points are not closed down until new ones are set up in positions occupied by the troops.

The medical service is responsible for organizing the sanitary examination of sources of water on territory abandoned by the enemy, chiefly along the main routes. The main purpose of this examination

is to determine whether the water is fit to drink. To prevent the consumption of unsuitable water, appropriate marks are made and the water denatured by adding to it large amounts of chlorinated lime, cresol, creolin, phenol, etc.

During the large-scale offensives of World War II mobile sanitary-epidemiological detachments and laboratories advanced with the troops and made chemical, toxicological, and bacteriological analyses of the water. The major effort was focussed on the sources to be used in connection with supply points. Regimental or division medical personnel were responsible for checking on treatment of the water. They used the mobile sanitary-epidemiological laboratories for analysis and control over the completeness of disinfection and decontamination.

In the event of planned infection or poisoning of the water in open and bore wells by the enemy, the attacking troops must be supplied with water brought from the rear. At the same time measures are taken to dig small tubular wells, which can be done in three or four hours. In the absence of such wells, field-type wells are dug on the cleanest portions of captured territory, if the level of ground water permits.

Water Supply for Troops on the Defensive. Troops in defensive positions are supplied with water primarily from ordinary shaft wells. These are dug by combat troops and each company has its own well. This "autonomous" water supply system was widely used on the Leningrad and Karelian fronts.

The Manual on Field Supply of Water to Troops specifies that permanent and emergency points are to be set up as closely as possible to the consumers, i.e., to military units, hospitals, and other rear installations.

Supply points and reserves must be well protected against contamination by atomic, chemical, or bacteriological weapons. They must meet camouflage requirements and be accessible to the troops, field kitchens, and boilers.

Depending on local conditions and the combat situation, water supply points are built at the rate of one for each battalion, regimental aid station, or other rear installation, and sometimes for each company.

In the event that the enemy attempts mass contamination, the troops are supplied from a limited number of points where the water contains no radioactive substances, poison gases, or bacterial toxins.

Battalion water supply points are set up for first echelon companies next to trenches or communication trenches; for second echelon companies they are set up around battalion ration distributing points.

Water may be brought up from the rear only in exceptional cases. The unit then stores it in places protected from enemy fire. It is essential that the water be safeguarded from radioactive substances, poison gases, pathogenic microorganisms, and bacterial toxins. The water is kept in closed containers and chlorinated in such a way that the amount of residual chlorine ranges from 0.2 to 0.5 mg/l.

Water is supplied to shelters from shaft or tubular wells. Lakes or streams may be used provided that the water is disinfected. The rate of consumption is established in conformity with the instructions of the Manual on Field Supply of Water to Troops. In determining the consumption of water in a shelter, the following must be taken into consideration: (1) number of people present; (2) proposed length of stay there; (3) approximate rate of consumption per man per hour; (4) use of water for housekeeping and medical purposes. If necessary, estimates are made of the amount of water needed for the electric power plant and for cooling the air fed into the shelter.

It has been determined that individuals in permanent installations require three to five liters a day of tap water and about two liters of well water. In field-type shelters the minimum amount of drinking water required is two liters per man per day, about three liters for personal hygiene and washing dishes. Water in shelters must be stored in tanks protected against contamination by poison gases, radioactive substances, and pathogenic microbes.

In defending major inhabited localities the troops may use community water works if the distribution facilities, artesian wells, pumping stations, sedimentation tanks, and filters are well protected. It is particularly important that there be no interruptions in the supply of water to centers of resistance and strong points. In addition, every such point must have bore or shaft wells as well as reserves in case of breakdown or destruction of the municipal system.

If part of the system is destroyed, distribution points are built at the intact sections with a supply of disinfected water. Supply points are set up if there are water sources of the closed type within the city. The water from lakes and rivers may be used only after careful laboratory analysis.

In regions of permafrost steps must be taken to prevent surface sources and underground waters from freezing.

In the winter, if there are no other sources, water can be obtained from snow gathered from unpolluted areas, particularly during snowfalls. Ice should be stored where there are open bodies of water.

Ice and snow must be analyzed before they are used. In a modern war atmospheric precipitation, snow and ice on lakes and rivers may be contaminated by radioactive substances, poison gases, pathogenic microorganisms, or bacterial toxins.

In the mountains all kinds of sources are used, including water under the beds of dried out streams. Water in the region of glaciers is prepared from ice and snow.

Water Supply for Troops on a March. Water supply planning for troops on a march is related primarily to the availability and quality of water, both on the line of march and at night halts. The Manual on Field Supply of Water to Troops specifies that water is to be supplied at the rate of 75% of the daily requirement at night halts and 25% at major stops during the day. If a major stop is not planned or there is

no source at the site scheduled for a major stop, water is transported in boilers and kitchens as well as in standard and improvised receptacles.

The amount of water required is estimated from the rate of consumption on a march, amount of water, availability of transport facilities, receptacles, etc.

By the time the troops reach the place where they are to spend the night, 0.5 liter of water must be made available for each man. This water is to be issued promptly so that the soldiers can quench their thirst within 30 minutes. If it is impossible to provide the water locally, they must carry it along with them.

Equipment for obtaining, purifying, and disinfecting water at the site of the night halt is sent ahead to the supply point to assure the troops water for drinking, cooking, and washing when they get there. In addition, water distribution points are set up in advance along the line of march so that the men can be taken care of on the way.

The engineering service in cooperation with the medical service is responsible for organizing water supply and distribution points.

In arid regions these points are set up at distances equal to half the day's march. Some 50% of the supply is stored at major stopping places and the entire daily requirement at night halts. Additional supply or distribution points with reserves amounting to 25% of the daily requirement are set up at intervals between the principal points.

The main tasks of the medical service in supplying water to troops on a march are: advance sanitary reconnaissance of sources of water en route, evaluation of its quality, purification and disinfection, and providing the men with chemicals for disinfecting the portable supplies.

Water Supply in Regions of Permafrost. Along the shores of the Arctic Ocean lies the permafrost zone, i.e., a layer of frozen soil that thaws out only on the surface over a short summer. The southern boundary of unbroken frozen ground in the USSR proceeds north of Arkhangel'sk and south of Yakutsk in Siberia. Individual portions extend comparatively far to the south.

The earth lying above the permafrost is called the active layer. It is 2 to 4 m thick for sandy soils, 1.5 to 3 m for clay soils, and 0.8 to 1.5 m for peat and swampy soils. The thickness of the frozen layer varies considerably, sometimes exceeding 100 m. The temperature ranges from 0.3 to 2° below zero.

The vast expanse of permafrost and the fact that it originated under a great variety of geological conditions severely complicates the task of supplying water in the field. Underground water strongly affects and is in turn affected by permafrost.

Soviet investigators have shown that in regions of permafrost water may be found under frozen ground in the alluvial layer. Sometimes the water breaks through the surface from great depths in the form of concealed or open springs. In some places water is obtained from

under the permafrost by means of artesian wells. Bodies of open water are formed as a result of the runoff from atmospheric precipitation and subterranean sources.

Ground water (the so-called seasonal water) is formed in the regions of permafrost by the seepage of rain and condensation of water vapor during the frost-free periods of the year. Ground water is formed in the alluvial layers of valleys and rivers. These alluvia cannot store much water because of the underlying frozen ground and deep freezing of the upper layers of the soil in the winter.

Ground waters from the layers above the permafrost differ in their irregular flow. They often dry up by the end of the winter. In the winter they are under the pressure of two layers of soil: winter frozen ground and permafrost. A rise in hydrostatic pressure sometimes causes the ground frozen in the winter to crack with an outflow of water and formation of pools on the surface. Ground water may break through into the cellars of buildings because the water pressure encounters the least resistance here and results in inundation of the buildings.

Ground water in a permafrost zone is capped by an ordinary excavation with wood or concrete reinforcement of the sides.

Sometimes subterranean drainage galleries are constructed. It will be remembered that the rapid illuance of water from the galleries exhausts the water-bearing layer and lowers the depression. The result is intensified (sometimes total) freezing of the ground from the surface.

Wells are kept from freezing by tightly fitting covers, which are put on when the day is very cold. The mouth of the wells has a warming layer within a radius of at least 3 to 5 m.

If a water-collecting subterranean gallery is dug instead of a well, it too is warmed from the surface by a layer of fill.

The flow rate of water-collecting installations is determined during the critical period, i.e., in March. Test pumpings are carried on until the permanent horizon of the water is established.

Ground waters in regions of permafrost generally differ in degree of softness. Some of them contain iron.

The most constant and abundant sources of water in a permafrost zone are springs bubbling up through cracks in the faults of regions with sunken areas. Springs yield insipid and mineralized water. In many springs the water contains carbonic acid or nitrogen. The former is cold, the latter warm.

Breaking through the permafrost layer, springs come to the surface along the slopes of valleys and on the peaks of mountains. They saturate the alluvia resting on the permafrost and create swamps. An occasional spring forms a visible stream. In the winter spring water forms a layer of ice. The best time to look for these springs is in February and March when they can be easily detected from the mounds and ice.

Rivers in a permafrost zone often freeze to the bottom. In a severe winter the ice cover may be 1 to 1-1/2 m thick. Small rivers freeze right to the bottom and flow only within the bottom deposits. Occasionally even the deposits freeze to a depth of 0.5 to 0.8 m. Large rivers flow all winter. Water temperatures in the rivers are close to zero.

Rivers in a permafrost zone have still another peculiarity. Sometimes after the first layer of ice is formed, the level of the water drops rapidly whereupon a second layer is formed under the first and a third under the second. The result is several ice covers separated by hollow spaces. This must be kept in mind when determining the suitability of water for troop use.

Water Supply for Troops in Mountains. The task of supplying water to troops in mountainous areas is facilitated by the existence of large amounts of pure, unpolluted snow and ice. The only difficulty is the lack of fuel to thaw them.

In a modern war there is always the possibility that the enemy may contaminate the snow and ice with poison gas, radioactive substances, or bacterial preparations. Hence, laboratory analysis of the snow and ice, even at great altitudes, is essential.

A major defect of water obtained from melted snow and ice is its insipidity caused by the lack of mineral salts. Moreover, it is not only the taste that is a concern. Body functions may become seriously impaired if the organism is deprived for a long time of several microelements (compounds of iodine, fluorine, copper, manganese, cobalt, etc.). Thus, in the mountains it is necessary to prospect for springs that are rich in mineral salts. If they can't be found, lime water and sodium chloride (in amounts not perceptible to the taste) must be added to the water obtained from snow.

In mountainous areas water supply points are set up along the banks of rivers, near springs, and on glaciers. The water is transported by trucks and pack animals as well as by porters using authorized and improvised receptacles.

The sites for processing snow and ice are away from sources of pollution, i.e., places where there are people, animals, roads, pack trails, etc. If the troops are disposed along the banks of a mountain stream, the places where the water is to be used are selected in accordance with the requirements set forth by the Interior Service Regulations.

Water Supply in Deserts. Water is generally issued to troops in hot, desert regions at supply points. The water, regardless of source (well, reservoir, irrigation ditch), contains substantial amounts of suspended matter of mineral and organic origin. Effective disinfection requires preliminary coagulation and filtration. However, chlorination in a hot climate seriously impairs the odor and taste of water. It is therefore recommended that the water be acidified with tartaric or citric acid. If this is impossible, the canteens should be filled with chilled tea.

Water from ditches and other open streams may contain *Entamoeba histolytica* cysts, which are extremely resistant to chlorine. If there is a threat of amoebic dysentery, the water must be disinfected, coagulated and filtered.

CHAPTER VII

NUTRITION HYGIENE

Introduction

The nutrition of Soviet soldiers in peacetime is based on physiological and hygienic data involving the use of freshly baked bread, hot and frozen meat, fresh or smoked fish, fresh or pickled vegetables. Food is prepared in well equipped military kitchens and served in dining halls with ample supplies of dishes and implements.

In wartime, however, the situation changes radically. Instead of fresh food there are preserved meat, fish, and vegetables; biscuits replace bread; fresh vegetables often give way to dry vegetables, and vermicelli or macaroni sometimes takes the place of potatoes.

Conditions in the field necessitate a reduction in the variety and number of prepared dishes. One must often be contented with two servings of hot food a day. Field kitchens are not equipped to prepare certain foods that make up a regular part of the peacetime diet.

In a modern war the troops will obviously have to rely on concentrated foods, prepared or half-prepared, e.g., bread that doesn't get stale, powdered milk products including butter, powdered eggs, dry pressed vegetables, frozen pressed meat, etc. This is dictated by the necessity of: (1) providing for the most efficient use of containers and transport facilities; (2) safeguarding food against contamination by poison gases, radioactive substances, pathogenic microorganisms, and bacterial toxins; (3) facilitating the preparation of food in field kitchens and mess tins.

Inspection of the transportation and storage of food is thus facilitated. On the other hand, the tasks of the sanitary experts are greatly complicated by the possibility of contamination by poisons, radioactive substances, and bacterial preparations. It is very important that food in warehouses, and above all while it is in transit, be fully protected. Attention must be given to packaging materials and wrappers that cannot be penetrated by radioactive, chemical, or bacterial aerosols. This material must not only protect the food, but also permit it to be decontaminated in the package.

Soviet Army Food Rations

The basic soldier's ration before the war consisted of 112 g of proteins, 65 g of fats, and 615 g of carbohydrates, with an energy value of 3,630 calories. The items afforded a fair variety of food. The daily issuance of 150 g of meat, 100 g of fish, 30 g of animal and 20 g of vegetable fats enabled the units to have three meals a day.

The vitamin requirements were satisfied chiefly by products of vegetable origin. There were 820 g of vegetables, including 500 of potatoes, 170 g of fresh cabbage or sauerkraut, 45 g of carrots, 40 g of beets, 65 g of onions, culinary roots, and greens.

In a decree dated 12 September 1941 the State Committee on Defense introduced new food allowances for wartime. They remained unchanged until the victorious end of World War II (Cf. Opyt sovetskoy meditsiny v Velikoy Otechestvennoy voyne 1941-1945 [Experience Gained by Soviet Medicine in World War II, 1941-1945], Vol 33).

Figures on the composition and calorie value of Soviet Army rations after the war are shown in Table 20.

TABLE 20

Type of rations	Food composition, in g			Calorie value
	Proteins	Fats	Carbohydrates	
Basic soldier	102	69	571	3,400
Vegetarian soldier	88	69	621	3,550
Special soldier	125	94	639	3,810
Military student	115	78	639	3,820
For pupils in Suvorov schools:				
(1) up to 14 years old	117	108	540	3,690
(2) 14 years and older	119	108	560	3,790
Mountain altitudes:				
(1) from 1.5 to 3 km	129	83	721	4,260
(2) above 3 km	140	92	722	4,390
Hospital	91	75	517	3,200
Sanatorium	125	103	567	3,800
Dry	131	74	574	3,580

Army doctors are responsible for: (1) inspecting food reaching their units and determining its quality; (2) observing the execution of sanitary regulations governing the transportation and storage of food; (3) cooperating in measures to combat rodents and flies in places where food is stored; (4) cooperating in the preparation of weekly ration allowances for prescribed menus; (5) determining the calorie value of the daily ration and its protein content; (6) periodically forwarding samples of cooked food for laboratory analysis; (7) checking on the quality of cooked food; (8) checking on the vitamin content of foodstuffs and cooked dishes; (9) determining the quality of bread by organoleptic tests and laboratory analysis (if there are special indications for doing so); (10) medical checkup of personnel serving in warehouses, kitchens, and mess halls; (11) conducting hygiene education among cooks and others engaged in feeding the soldiers.

Caloric Value and Food Composition

In determining the nutritional value of the daily ration, army doctors must be able to calculate the amount of assimilable proteins, fats, and carbohydrates in the foods to be prepared as hot dishes and served directly to the men. The calculations are made from the table of composition and calorie value of foods by multiplying the weight of the item expressed in grams by the percentage of the item and then dividing the result by 100. The figures cited in the table are calculated for 100 g of the standard product taking into account average amounts of waste. If the actual waste exceeds the average, the whole thing has to be recalculated.

The amount of vitamins and mineral salts is calculated twice a month. In determining vitamin C, a correction must be introduced for the loss in cooking.

Nutrition Standards

In order to handle effectively the complex task of feeding both the troops and the civilian population during wartime, it is essential that nutrition standards be worked out for the various age and occupational groups. Differentiated standards of food allowances must also be set up for different categories of troops.

The proper kinds of food are just one of the prerequisites for good nutrition. Poor storage or unskilled preparation can ruin its quality. If the soldiers and officers are to be well fed, there must be skilled cooks and up-to-date kitchen equipment (steam autoclaves, meat grinders, vegetable cutters, potato peelers, etc.).

"Only palatable food is beneficial," said the great Russian physiologist, I. P. Pavlov. Quartermaster and medical personnel must strive to satisfy this requirement.

Nutrition standards are based on research on energy exchange. The daily energy expenditures of soldiers has been determined from investigations of gaseous exchange and time studies. The basic exchange, when a person is in a state of rest, is approximately one calorie an hour per kilogram of weight. For example, the hourly expenditure of energy by a soldier weighing 70 kg is 70 cal.

Basic Foods

After many years of investigating the conditions under which people work in various climatic zones and with different kinds of work loads, the Institute of Nutrition, Academy of Medical Sciences classified the people into four groups in terms of the caloric value of the daily rations. The first group includes those performing mental work and leading essentially a sedentary life (3000 cal). The second group consists of people performing physical, mechanized work (3500 cal). The

third group is made up of people performing heavy, partly mechanized work (4000 cal). The fourth group includes athletes and others engaged in heavy physical work (4500 to 5000 cal).

The amount of proteins, fats, and carbohydrates is determined from this estimate of the calorie value of the daily rations. According to the Institute of Nutrition AMS, proteins provide 14% of the calorie value, fats 30%, and carbohydrates 56%. This ratio must be maintained in all four types of daily ration. Consequently, group 1 must have 100 g of protein, group 2 120 g, group 3 140 g, and group 4 from 150 to 160 g. The amount of carbohydrates varies proportionately.

The body receives its full supply of vitamins and mineral salts only from a great variety of foods of animal and plant origin.

The physiological requirements of an adult for minerals, according to the Institute of Nutrition AMS, are 800 mg of calcium, 1,600 mg of phosphorus, and 15 mg of iron.

The vitamin requirements of the different age groups are shown in Table 21.

TABLE 21

Population group	Vitamins							
	A							
	I.U.	mg	carotene, mg	B_1 (thiamin), mg	C (ascorbic acid), mg	PP (nicotinic acid), mg	B_2 (riboflavin) mg	D (calciferol), I.U.
1. Adults								
a) moderate work	3,300	1	2	2	50	15	2)	
b) heavy work	3,300	1	2	2.5	75	20	2)	up to 1000
c) very heavy work	3,300	1	2	3	100	25	2)	
2. Pregnant women (5-8 months)	6,600	2	4	2.5	75	20	2	500-1,000
3. Nursing mothers (up to 7 months)	8,300	2.5	5	3	100	25	2	500-1,000
4. Children								
a) up to 7 years	3,300	1	2	1	30-35	15	2	500-1,000
b) between 7 and 14 years	3,300	1	2	1.5	50	15	2	500-1,000
c) above 14 years	3,300	1	2	2	50	15	2	500-1,000

Note: Vitamin requirements are expressed in the table in three ways: (1) in international units (I.U.), (2) in milligrams of vitamin A, and (3) in milligrams of carotene.

Note to Table 21, continued.

1 mg of vitamin A is equal to 3,330 I.U.; 1 mg of carotene (β-carotene) is equal to 1,660 I.U. One international unit of vitamin is equal to 0.000025 mg of chemically pure vitamin D (calciferol). One international unit of vitamin A activity is equal to the activity of 0.0006 mg of carotene (β-carotene) or 0.0003 mg of vitamin A.

Up to 1.5 mg of vitamin (corresponding to 3 mg of carotene — about 5,000 I.U.) may be supplied in the form of food products. Amounts above 5,000 I.U. must be supplied through the corresponding preparations (carotene or vitamin A).

Preparations of vitamins D and PP are taken only on a doctor's prescription.

On the basis of the Institute's observations, V. V. Yefremov suggests that the daily amounts of vitamins be increased for those living in the Far North. Those performing physical labor require about 100 mg of ascorbic acid (about 200 mg for nursing mothers), 30 to 40 mg of nicotinic acid. In addition, some 250 I.U. of vitamin D should be supplied to adults and 5,000 to 1,000 I.U. to children and youths up to 2[illegible] years of age.

N. N. Yakovlev has observed that athletes in heavy training also require increased amounts of vitamins, primarily B_1, C, PP, and to some extent A.

It must be borne in mind that the amount of vitamins needed to prevent avitaminosis differs markedly from the physiological norm, which is much higher than the so-called prophylactic man-dose. There is no uniform vitamin requirement for all people. It varies with the external conditions and character of the physical load. The norms must change for those soldiers detailed to the Arctic or Far South, those assigned heavy physical work, etc.

Proteins. According to modern thinking, man needs different amounts of protein depending on his age. During a day children up to one year require 3.5 to 5 g per kg of body weight; children from one to three years need somewhat less, 3.5 to 4 g/kg. Adolescents 14 years and older need 80 to 100 g, adults 1 to 1.5 g per kg of body weight.

Protein allowances change if the environmental conditions change (hot or cold climate) or if the physical load decreases. They increase for youngsters and decrease for elderly people. The need of protein increases to 150 g or more with heavy physical work and decreases with light work. Protein requirements increase in a hot climate or in connection with work in hot shops due to the disintegration of protein and its decreased assimilability.

The protein allowance in Soviet Army rations ranges from 88 g (vegetarian) to 104 to 172 g (general summer and special summer).

Animal proteins are usually combined with a substantial amount of fats and a small amount of carbohydrates. With vegetable proteins, on the other hand, little fat and, as a rule, much carbohydrate is included.

TABLE 24. CONTENT OF IRREPLACEABLE AMINO ACIDS IN 100 G OF BREAD, IN G

Name of amino acid	From flour of 100% yield	From flour of highest quality
Lysine	0.24	0.21
Leucine	1.08	1.24
Isoleucine	0.41	0.38
Methionine + cystine	0.41	0.50
Phenylalanine + tyrosine	0.81	0.91
Threonine	0.29	0.28
Tryptophan	0.08	0.09
Valine	0.41	0.35
Arginine	0.28	0.39
Histidine	0.17	0.22

Fats. The amount of fats in army rations is related to culinary requirements, character and size of the physical load, climatic features of the region where the soldiers are stationed, and the intervals between meals. It is assumed that an adult requires at least 1 g of fat per kg of body weight. According to A. Ya. Danilevskiy, 18% of the daily gross caloric content of a soldier's diet must be provided by fat. In seeking to raise the pre-revolutionary Russian army ration to 4,000 cal, Danilevskiy thought it necessary to include 77 g of fat.

The "Physiological Norms of Feeding the Population of the USSR," as worked out by the Institute of Nutrition, Academy of Medical Sciences USSR, call for an increase in fat to about 30% of the total calorie content of the diet. This means 113 g of fats in a ration calculated for an energy expenditure of 3,500 cal. It is hard to justify on physiological grounds such a high allowance of fats even in the rigorous climate of the Arctic region. It is also contraindicated for elderly people for clinical reasons.

Vegetable as well as animal fats are used by the Soviet Army — butter, boiled butter, beef and mutton fats, lard, solid hydrogenated fats.

According to the All-Union State Standard 465-41, the Soviet Union produces the following food fats: (1) animal, consisting of 15% beef and mutton fats, hydrogenated and vegetable oils; (2) swine, containing 15% boiled lard, hydrogenated fat, and vegetable oil, and (3) margoguselin, consisting of 80% margarine fat base and 20% lard. An extract obtained by frying onions in oil is added to margoguselin to impart the taste of goose grease.

The taste, odor, constitution, and color of animal fats change if they are kept for a long time. Glycerin and monobasic acids are formed in the process. Glycerin formed when fat spoils is rapidly broken down by bacteria, whereas the acids are more stable and break down more slowly.

Light, oxygen and microorganisms may change and spoil fats. One reason for bacterial contamination may be the wooden container, which is difficult to disinfect. This may also happen while the fat is being processed, shipped, or stored. It is a well known fact that fat melts at 50 to 55°, i.e., at a temperature insufficient to decontaminate it. Antioxidants are used to prevent the oxidation of fats and, consequently, food concentrates from turning rancid.

Carbohydrates. Carbohydrate requirements are determined by the amount of muscular work performed. The more intense the muscular work, the greater the amount of carbohydrates included in the daily ration. Athletes in training and soldiers on a march or engaged in heavy physical work (building defensive installations, bridges, roads, etc.) are in particular need of carbohydrates.

The analysis of army food rations in various countries shows that they differ considerably in carbohydrates, although the amount of proteins is about the same (some 100 g daily per man). This is due to the different proportion of fats and carbohydrates in the food: the more fats, the less carbohydrates, and vice versa.

Based on 1 g of fat per kg of body weight, a daily fat allowance of 70 g should call for 400 g of carbohydrates with light work, 500 g with moderate work, and more than 800 g with heavy work. It must be kept in mind that a person works more efficiently and with less fatigue if there is a predominance of carbohydrates in the diet. However, if fats predominate, there is an energy loss of more than 10% in performing physical labor. The complete utilization of carbohydrates requires a certain minimum of fat in the diet.

Salt in food. The mineral compounds found in food are conventionally divided into two groups: macroelements (calcium, phosphorus, magnesium, sodium, potassium, chlorine, and iron) and microelements (iodine, fluorine, bromine, copper, zinc, arsenic, manganese, aluminum, chromium, cobalt, and many others). The microelement content of food does not exceed 1 mg%.

There is still no settled view as to the amount of minerals needed by man. Daily norms have been established only for calcium, phosphorus, magnesium, and iron.

It is generally believed that the daily adult diet should contain approximately 800 mg of calcium, 1,200 mg of phosphorus, 600 mg of magnesium, and 15 mg of iron. Soviet Army rations contain 900 to 1,100 mg of calcium, 2,400 to 2,500 mg of phosphorus, about 400 mg of magnesium, and 15 to 20 mg of iron. Consequently, the soldiers' requirements for mineral elements, except magnesium, are covered with something to spare.

The situation is somewhat different as regards the proportion of minerals, especially calcium to phosphorus and calcium to magnesium. The phosphorus content should be 1-1/2 to 2 times that of calcium, i.e., about 1.2 to 1.5 g.; magnesium should comprise 0.5 to 0.75 g (the proportion of Ca to Mg should be as 1:0.50 or 1:0.75). In cases where magnesium salts predominate over calcium salts, there is usually intensified excretion of calcium from the body.

With restricted intake of mineral salts, the amount excreted is usually sharply reduced, the result being that the total salt content of the body drops slightly. However, there is continued excretion of calcium even after intake has been curtailed or during complete starvation. Consequently, the calcium level is substantially lowered. This peculiarity of calcium exchange makes it essential that army doctors strive to have calcium salts included in the diet.

The most favorable proportion of calcium to phosphorus is found in cabbage and milk products. The proportion is highly unfavorable in meat, fish, rye and groats (especially millet). The daily consumption of vegetables is extremely important in regulating the mineral and salt composition of food. Hence, the practice of substituting groats, particularly millet, for vegetables should not be tolerated.

In setting up daily calcium norms it should be remembered that they are determined not so much by the absolute amount of calcium included in the food as by its proportion to the other salts (phosphorus and magnesium) and by the fat content of foodstuffs and cooked food. If the proportion of these items is normal, 800 mg of calcium daily are sufficient for health.

To increase the content of calcium salts in the soldiers' rations, it is necessary: (1) to take the calcium balance into consideration when planning menus; (2) to include milk and milk products wherever possible (especially cheese, which contains about 1,000 mg% of Ca); (3) to use vegetables and fresh greens (beet tops, sorrel, nettles, etc.); (4) to achieve the optimum ratio of calcium to phosphorus; (5) to check on the vitamin D content of food and synthesis in the organism. This vitamin regulates the phosphorus-calcium exchange.

Potassium and sodium salts, chiefly in the form of KCl and NaCl, may be absorbed in limited amounts through the intestine. The danger of impaired osmotic pressure of the blood and tissue fluids is eliminated by intensified excretion of these salts through the kidneys and by increased drinking of water or beverages because of thirst.

Potassium and sodium cations appear in the organism in the form of chlorides, bicarbonates, and phosphates; part of them is bound with proteins and organic acids. Potassium is usually found in the cells, sodium in intracellular matter and tissue fluids. Sodium chloride, for example, is present in the blood in the amount of 0.85%. It ensures a certain level of osmotic pressure of the blood (V. Vasil'yev).

Potassium salts, the daily requirement of which is 2 to 2.5 g, are supplied chiefly by plant products; meat is one of the foods of animal origin that is rich in potassium.

Sodium, unlike potassium, is not found in the cells (in bound form), but is present as a solution.

Some 15 to 20 g of sodium chloride enters the body daily as a necessary seasoning of food. According to R. Muller, the minimum daily requirement of NaCl is 2 g. The need of salt increases after heavy perspiration due to the fact that it is eliminated through the sweat glands. Sodium chloride is the main inorganic compound in perspiration.

It is important to note that the body loses its K, Mg, and Ca ions if too much salt is consumed either as seasoning or with such foods as herring, ham, corned beef, smoked products, etc.

Microelements. Certain chemical elements are present in plant and animal organisms in amounts ranging from 10^{-3} to 10^{-12} percent. These include, among others, copper, zinc, cobalt, manganese, molybdenum, iodine, bromine, fluorine, and arsenic. Insufficient or excessive amounts in water and food may affect the health.

There is no doubt that microelements affect the activity of hormones and endocrine functions. It is believed that copper, cadmium, and cobalt are involved in the action of adrenalin. Bromine weakens the functioning of the thyroid. Zinc increases the activity of the gonadotropic hormone elaborated by the pituitary gland (V. V. Koval'skiy).

It has recently been established that microelements also have some connection with vitamins. It is known, for example, that cobalt is an essential constituent of vitamin B_{12}. It is worth noting that this vitamin, which plays such an important part in the treatment of pernicious anemia, is produced by microorganisms.

The relation of certain microelements to vitamins has been repeatedly demonstrated. It is generally believed that the presence of manganese is related to the storage of vitamin B_1 in rice and the synthesis of ascorbic acid in plants and that iodine inhibits the synthesis of vitamin A, while fluorine intensifies the effect of vitamin D (V. V. Koval'skiy).

Thus, many microelements, which are closely connected with vitamins, enzymes, and hormones, strongly influence the metabolic processes.

Manganese is an important microelement in human tissue. The daily requirement is 3 to 5 mg for persons not engaged in physical labor and 8 to 10 mg for those who are. Manganese is eliminated from the body in the same amounts. According to A. Maslova, the manganese balance in man may be positive or negative depending on the physical load.

Iron and copper and some other microelements are absorbed by the body only when bound with proteins.

Vitamins

The Russian physician N. I. Lunin is the creator of the modern theory of vitamins. He was the first to show (1880) that in addition to proteins, fats, carbohydrates, and mineral salts, man and animals need other substances, which C. Funk later called vitamins. Lunin made the outstanding discovery — in his own words — that "A natural food as milk must obviously contain still unknown substances necessary for life besides its familiar main ingredients."

Due to the impeccable way he conducted his experiments, the young investigator was the first person in the history of science to induce experimental avitaminosis in a substantial group of experimental animals (mice).

Lunin's remarkable achievement in demonstrating the presence of a fifth group of food components in the diet of man and animals failed to win recognition in his time. It was more than 30 years later that this group, which differs in nature and physiological action from proteins, fats, carbohydrates, and mineral salts, was discovered by foreign scientists (F. Hopkins, K. Eichmann, C. Funk, and others).

It would be a serious error to regard Lunin's discovery of vitamins as an accident unrelated to the earlier development of science in Russia. Lunin had a galaxy of predecessors who made an important contribution to the theory of qualitative inadequacies in the diet of soldiers and civilians.

V. V. Pashutin in his Course on General and Experimental Pathology (1902) correctly understood the cause of scurvy: "Scurvy should be included with the nutritional disorders, recognizing therein the effects of a form of partial starvation."

This view was not only new, but courageous for its time. The fact is during the second half of the 19th century most investigators expressed themselves in favor of the infectious etiology of scurvy. R. Koch adhered to this view, although he was unable to isolate the causative agent. Scurvy was mentioned in the section on "Infectious Diseases" in official reports on the sanitary condition of the Russian Army prior to World War I. It was Pashutin's merit to have attributed the development of scurvy in man to a deficiency in his food of some organic substantance not synthesized in the body.

The theory of vitamins became firmly grounded in the Soviet Union after the Great October Socialist Revolution. Soviet experts were at first confronted with the practical task of combatting avitaminosis among the troops and civilian population.

A profound study of the biological action and chemical nature of vitamins has shown that they do not constitute a homogeneous class of substances. It has been concluded from data on their action mechanism that they are catalytic agents of processes taking places in the tissues of the animal organism. They participate in these processes as coenzymes -- components of complex fermentative systems.

At present we understand by vitamins a large group (about 20) of complex organic substances of varied chemical nature that are physiologically active in small doses, enter the organism with food, and act as catalysts in metabolism (B. A. Kudryashov).

Vitamin A. Vitamin A plays a vital role in the diet of troops. Adaptation of the eye to seeing in the dark is related to adequate amounts of vitamin A or carotene in the food. If vitamin A or carotene is deficient in the diet, acuteness of vision at twilight and color perception is affected along with a narrowing of the field of vision. If

the deficiency is prolonged, hemeralopia (day blindness) develops requiring hospitalization. It retards the regeneration of visual purple, which disintegrates under the influence of light on retinene (the aldehyde of vitamin A) and on the white of the eye. It also reduces the speed with which the eye regains its visual sharpness after exposure to light.

Wartime experience showed that several other factors strongly affect adaptation to darkness: fatigue, physical and neuropsychic tension, insomnia, bright lights, prolonged eyestrain under conditions of inadequate light, etc.

Soldiers suffering from hemeralopia complain of sharply reduced vision in the twilight and at night. This is due to impairment of the rod apparatus of the retina. Day vision, which is dependent on the cones, is ordinarily not affected. Complaints are investigated by anamnesis, eye examination, and general examination to discover any diseases that may be accompanying the nutritional disorder. Occasionally there are also objective symptoms — whitish plaques (Bitot's spots) on the conjunctiva of the eyeball within the palpebral fissure. These plaques are soft flaky masses. Xerophthalmia, characterized by dryness of the cornea and loss of its luster and sensitivity, is observed in rare cases of hemeralopia.

The initial symptoms of A-vitaminosis show up in the form of follicular hyperkeratosis against a background of pale and dry skin.

Persons suffering from general malnutrition along with hemeralopia may also have the following conditions: meibomianitis, styes, blepharitis, edema and tumescence of the eyelids, dryness and desquamation of the skin. Sometimes there are symptoms of asthenopia, expressed in photophobia, pain in the eyes, difficulty in reading, etc. Other symptoms of A-vitaminosis are cornification of the skin, pyoderma, stomatitis, loss of weight, general weakness, and lowered resistance to infectious diseases. In the absence of objective manifestations the presence of hemeralopia is indicated by functional eye disorders, primarily poor dark adaptation.

Table 21 shows the daily adult requirement of vitamin A. 5,000 I.U. of vitamin A or 3 mg of carotene is the minimum dose for soldiers. It is highly desirable, if not essential, that efforts be made to substitute vitamin A for at least one-third of the carotene.

Vitamin A is found only in foodstuffs of animal origin — milk and milk products (except pot cheese and curdled milk), suet, and fish fat. The vitamin A in milk and milk products varies with the time of year. Vegetables contain provitamin A or carotene, which is converted into vitamin A by the body. The physiological and biochemical processes of converting carotene into vitamin A are still not fully understood.

According to S. N. Matsko and Ye. V. Zavadovskaya, vitamin A has at least twice the biological effect of beta-carotene. The difference is even more pronounced with larger amounts. Consequently, an adult's diet must include vitamin A along with carotene.

Carrots, tomatoes, red peppers, rowanberries, apricots, lettuce, cabbage, nettle and sorrel leaves are good sources of carotene. Carrots are particularly rich in carotene (7.65 mg%). It is recommended that carrots be pickled for retention of their carotene during the winter, and, particularly, the spring when there is a danger that hemeralopia may develop.

The products containing vitamin A and carotene that are normally supplied to the Soviet Army include butter, fish, carrots, tomatoes, and other fresh vegetables. The main sources of vitamin A in the rations are meat, fish, and animal fats, which cover 15% of the daily requirement; the other 85% is supplied by carotene. The actual content of vitamin A in cooked dishes is determined primarily by the method of preparation. Vitamin A is destroyed in fruits and vegetables dried in the sun and in foods cooked too long and exposed to the air. Stewing in closed pots, storage in cold places, or sulfitization has no adverse effect on vitamin A.

The vitamin A (carotene) content of food lacking fresh carrots and other vegetables drops from 3.5 to .7 mg. When vegetables in the rations are replaced by groats and macaroni, the carotene content drops 3.5 to 0.15 mg. That is why army doctors must see to it that there is a variety of vegetables and that any lack of carrots is compensated for by various kinds of greens or vitamin preparations.

Fresh red pepper contains 13.9 mg% carotene, dried red pepper 22.4 mg% (V. N. Bukin).

Rowanberries and rowan flour made from dried skins of the fruit after removal of the juice are a prime source of carotene. Flour from washed skins (to get rid of the bitter taste) contains about 80 mg% carotene; flour from dried rowanberries contains about 15 mg%.

Carotene-rich oil is obtained from buckthorn berries [Hippophae rhamnoides L.] after the juice is squeezed out. An orange-colored oil containing 10 to 100 mg% carotene floats to the top of the juice. Frozen buckthorn contains 8 mg% carotene. The skins from which jam or puree may be made contain approximately 16 mg% carotene.

During the spring and summer the food can be vitaminized by providing such carotene-rich items as nettles (14 mg%), beet tops (7.5mg%), sorrel (5 mg%), green beans (8.1 mg%), etc. They should not be cooked more than 30 minutes to preserve the carotene. The greens are then mashed or passed through a sieve and added to a dish before it is fully cooked.

The vitamin content of food is known to change with the variety of items, time of year, and method of preparation. The investigations of S. N. Matsko and his co-workers are of great practical value here. He observed the effect of vitamin A when systematically introduced into the organism. He showed that weekly intervals have no noticeable effect. However, the effect is reduced one and one-half times when taken at two-week intervals while at four week intervals it is half that when taken daily. Research on animals has revealed that while vitamin A can be deposited in the body, it must be taken systematically.

To enrich cooked foods with vitamin A, it is convenient to vitaminize the fats used in preparing the first and second courses. Research conducted by the Institute of Nutrition, Academy of Medical Sciences USSR, and the State Vitamin Control Station (S. M. Bessonov and S. N. Matsko) indicated that a fair amount of vitamin A and carotene introduced into edible fat (combined fat) was retained during the preparation of food. The largest amount of carotene was retained in potato soup and sauerkraut soup (from 70 to 80%). Lesser amounts of vitamin A were retained (35 to 45%) in cabbage and (40 to 55%) in potato soup. Boiled and browned potatoes retained a fairly high percentage of vitamin A and carotene (70 to 80%). Maximum retention was observed in roast meat (29 to 33% for vitamin A and 6.5 to 11% for carotene). There was virtually 100% retention of vitamin A and carotene in uncooked foods.

Hemeralopia is treated in the army with some preparations containing vitamin A, chiefly cod-liver oil, one gram of which contains 30 I.U. of vitamin D and 350 I.U. of vitamin A. Vitaminized fish fat put out by our drug industry contains 160 to 270 I.E. of vitamin D_2 and 400 to 500 I.U. of vitamin A in a single gram. Consequently, the vitamin activity of the preparation is five to nine times greater than natural fat. In prescribing a tablespoon of cod-liver oil two or three times a day doctors often overdose: approximately 10,000 I.U. of vitamin D_2 instead of 500 to 1,000 I.U. of the daily requirement. This may bring on D-hypervitaminosis with symptoms of intoxication.

A more effective preparation is a concentrate of vitamin A, prescribed at the rate of one or two drops a day (its activity is equal to 200,000 I.U. per ml, which corresponds to 40 man-doses). Two to four drops a day of a vitamin A concentrate with an activity of 100,000 I.U. per ml (20 man-doses) are prescribed. Bonbons of vitamin A are prescribed at the rate of three to six a day (each piece contains 2,500 I.U. of the vitamin).

One of the measures advised for hemeralopia is to protect the eyes against bright light by wearing smoked glasses. If the symptoms do not disappear within five or six days, the patient is sent to a hospital for more detailed examination and treatment.

A vitamin A concentrate of 20,000 I.U. a day is prescribed in doubtful cases. If twilight vision completely returns within a week, the diagnosis of vitamin A deficiency as the cause of impaired adjustment to darkness is thereby confirmed.

Vitamins of the B group. These include vitamins B_1, B_2, B_{12}, PP, pyridoxine, pantothenic and paraaminobenzoic acids, biotin, inosite, and choline. Each has its individual chemical structure and possesses properties characteristic of it alone.

Sources of B-complex vitamins in army rations are bread, groats, meat, potatoes, and cabbage. Bread alone covers 58% of the daily requirement of B_1, 31% of B_2, and 54% of PP. The relationship between flour yield and B-complex vitamin content is shown in Figure 45.

Buckwheat, rye, and wheat are comparatively rich in vitamins B_1 and B_2. Among the foodstuffs of animal origin beef, pike perch, and bream are sources of nicotinic acid; mutton and cod are rich in vitamin B_1.

Yeasts are particularly rich in B-complex vitamins. They contain 2 mg% vitamin B_1, 4 mg% vitamin B_2, and 40 mg% vitamin PP.

Vitamin B_1. The lack or deficiency of vitamin B_1 (thiamine) in the diet creates the preconditions for the onset of a disease called alimentary polyneuritis. This disease affects the peripheral nervous system and is marked by locomotive disorders, clumsiness of movement, pain in the extremities and, eventually, paralysis and loss of sensation. At the same time there are also changes in the form of severe myocardial distrophy, enlarged heart, circulatory disorders, congestion in the lungs and liver, shortness of breath, and cyanosis. B_1-anitaminosis is characterized by the development of edema due to cardiac weakness and colloidal and osmotic changes in the tissues.

Army physicians are guided in diagnosing the condition by complaints of malaise, weakness, depression, irritability, ready fatigability, and insomnia. These are accompanied by tenderness in the gastrointestinal tract, loss of appetite, nausea, vomiting, achylia, intestinal atonia, and constipation. Muscular weakness, dyspnea, and tachycardia are characteristic of B_1-avitaminosis.

A flat sugar curve may be observed following an injection of 50 g of glucose. An elevated level of pyruvic acid in the blood is regarded as typical of the disease. This is due to the involvement of vitamin B_1, which forms part of decarboxylase, in the process of converting pyruvic acid into lactic acid. It has now been established that there is an inverse relationship between vitamin B_1 and the presence of pyruvic acid in the blood: the less vitamin B_1 entering the system, the greater the accumulation of pyruvic acid in the blood.

We learned during World War II that B_1-avitaminosis may develop not only because of the lack or deficiency of thiamine in the diet but also because of a heightened need of it. This may result from too much carbohydrate or too little protein and fat in the food. When the temperature is high, the need of vitamin B_1 rises sharply. The same thing happens after physical exertion (marching, building defensive installations), especially in the summer. There are grounds for believing that the increased demand of the body for vitamin B_1 is caused by the heavy loss of thiamine through perspiration.

With fever and intensified metabolism the body needs much more vitamin B_1. It has been observed that B_1-avitaminosis may develop as a result of angina, dysentery, malaria, and other diseases accompanied by elevated body temperature and metabolism. Chronic intestinal diseases in which the absorption and assimilation of thiamine is impaired constitute a source of secondary B_1-avitaminosis. The use of so-called bland diets which exclude black bread rich in vitamin B_1 is a cause of deficiency in hospitals.

Vitamin B_1 in army rations is supplied chiefly by plant products: cereals (wheat - 0.44 to 0.68 mg%, rye - 0.44 mg%), bread (white bread from coarsely ground flour - 0.31 mg%, rye with bran - 0.21 mg%), white cabbage - 0.16 to 0.26 mg%, carrots - 0.12 to 0.16 mg%, beets - 0.14 mg%, potatoes - 0.08 to 0.17 mg%, tomatoes - 0.08 to 0.16 mg%. The richest in vitamin B_1 are baking yeast and brewer's yeast. Then come barley germ, wheat germ, rice germ, lean pork, liver, egg yolk, bread from 100% yield flour, raw beef, and vegetables. Lentils are an excellent source of vitamin B_1.

The main source of vitamin B_1 in army rations is rye bread. 100 g of ordinary rye bread contain 0.21 mg of the vitamin. Consequently, the major portion of the daily requirement is almost completely supplied by 800 g of the bread. The more coarsely ground the flour and the greater the amount of bran present, the higher the vitamin content. However, it should be borne in mind that bread from coarsely ground flour is much harder for the human organism to digest.

Extensive research by Soviet and foreign investigators has shown that the vitamin B_1 content of wheat flour is determined by the presence of fragments from the germ, cyme, and aleurone layer. A good deal of these substances get into coarsely ground flour, which is why it has more vitamin B_1 than does finely ground flour where they are separated from the endosperm (V. L. Kretovich).

The tentative calculations of L. Ya. Auerman show that 550 g of bread from wheat or rye flour completely satisfy the vitamin PP requirement of man as well as two-thirds of the vitamin B_1 and about 15% of the vitamin B_2 needed daily by adults. White bread made of highest quality flour is not rich in all three vitamins.

It is evident from Figure 46 that the vitamin B_1 content of flour ground the same way rises sharply with an increase in yield from 60 to 85%. Raising the flour yield to more than 85% increases the vitamin B_1 content somewhat. At the same time, however, the quantity of inert materials (cellulose and pentosan) also increases.

V. N. Bukin, L. Ya. Auerman, and others have found that about 70% of the natural vitamin B_1 in flour is retained in rye bread and about 80% in wheat bread. Retention of the vitamin in bread baked with wheat flour of the first and second grades is higher — 86 and 88%, respectively.

If vitamin B_1 is added to the flour before baking, the bread keeps about two-thirds of the original amount — 75 to 80% for wheat bread.

Vitamin B_1 is well retained in drying. In calculating the requirement one must take into consideration the calorie value of the ration. It is believed that 0.23 to .30 mg of thiamine are sufficient for each 1,000 calories. Since very little thiamine is stored in the body and is quickly used up in illnesses marked by intensified metabolism, the daily dose of vitamin B_1 is almost double the minimum requirement after surgery and heavy physical loads.

The amount of nicotinic acid required by man is supplied by food along with tryptophan, which is the base for synthesizing vitamin PP with the participation of vitamin B_6. Since tryptophan is contained in protein, the amount of vitamin PP needed is also determined by the protein part of the ration. If the protein ration contains a good deal of tryptophan, the vitamin PP requirement decreases. It has now been established that PP-avitaminosis can be induced in experimental animals only by eliminating both nicotinic acid and tryptophan. If dogs are kept on a diet poor in vitamin PP and tryptophan, nicotinic acid exchange and conditioned reflexes become impaired. This is in full accord with the significance of changes in the central nervous system in development of the pellagra syndrome as established by Soviet investigators.

In working out the norms for nicotinic acid one must keep in mind the fact that its utilization in the body is related to an adequate amount of protein in the food. With a protein deficiency vitamin PP is rapidly eliminated from the organism. Consequently, substantial excretion of nicotinic acid with the urine is not a criterion for evaluating the normal state of nicotinic acid exchange in the organism (A. N. Tikhomirova).

Sources of vitamin PP in the army diet are bread, meat, liver, kidneys, soy, fine-ground barley, herring, and potatoes.

An analysis of the distribution of nicotinic acid in grain shows that most of it is found in the aleurone layer (the concentration of vitamin PP in the bran is many times greater than in the germ). This distinguishes nicotinic acid from vitamins B_1 and B_2, which are concentrated chiefly in the germ and cyme.

The processing of rye and, in particular, wheat causes a reduction in the content of nicotinic acid. In the superior grades of wheat flour the loss of vitamin PP amounts to as much as 63% and sometimes 74%. Moreover, it has also been established that the comparative decrease of nicotinic acid in wheat flour when milled is paralleled by the decrease of phosphorus and cellulose (I. Svetlov). The relationship between flour yield and content of vitamin PP is shown in Figure 47.

Baking bread does not destroy much vitamin PP; 95 to 100% of the original amount is retained.

When nicotinic acid is added to flour before baking, the bread retains about 80 to 87% of its vitamin PP. Yeast contains an unusually large amount of nicotinic acid (40 mg%). The daily requirement of vitamin PP is supplied by 200 g of fresh yeast, 30 g of dried or 100 g of compressed yeast. From 50 to 100 mg of nicotinic acid administered three times a day intravenously or subcutaneously at the rate of 0.5 to 1 mg per kg of weight in the form of a 1% solution is prescribed for therapeutic purposes. Pellagra may also be successfully treated with a liver extract (campolon or hepalone) injected intramuscularly. Improved protein nutrition is an essential prerequisite to effective therapy. Special attention must be paid to the richness of the protein allowance.

It is now believed that an adult requires 15 to 25 mg of nicotinic acid daily. The vitamin PP content of army rations is in excess of 20 mg. The high resistance of nicotinic acid to the heat of cooking is a reliable guarantee of adequate amounts of vitamin PP for the soldiers.

Vitamin B_6. The pathogenic significance of vitamin B6 (adermin, pyridoxine) has not yet been fully elucidated.

It has now been established that pyridoxine plays a part in protein and fat exchange as well as in the formation of the enzymes involved in amino acid exchange. Pyridoxine deficiency facilitates fat infiltration of the liver, impairs iron exchange, and causes dermatitis. Convulsions and adynamia occur in animals.

Vitamin B_6 is found in cereal germ, bran, yeast, and fresh vegetables (grains of cereals and legumes). Wheat grains contain about 0.46 mg% pyridoxine, fresh vegetables about 0.1 mg%, meat from 0.4 to 0.7%, milk about 0.1 mg%.

The daily B_6 requirement has not been established. It is believed that 1.5 mg a day are sufficient.

It is worth noting that pyridoxine can be synthesized in the intestine by the microflora.

Pantothenic Acid (Vitamin B_3). Pantothenic acid belongs to the vitamin B complex. Its name (which comes from a Greek word meaning "ubiquitous") indicates that it is widely distributed in nature. The pathogenetic significance of pantothenic acid is unclear. When the vitamin is deficient in their diet, animals exhibit changes in the nervous system, disorders of the trophic nerves, and impaired fat exchange. As a part of coenzyme A pantothenic acid is involved in acetylation reactions and many exchange processes. We still do not know how pantothenic acid deficiency affects man or what the symptoms are.

Pantothenic acid is found in yeast (about 20 mg% dry weight), bran, cereal germ, liver (7 to 8 mg%), meat (0.5 to 0.6 mg%), kidneys, egg yolk, and other foods.

It is believed that man needs about 5 mg a day or, according to others, 10 mg.

Biotin. Biotin is very common in foodstuffs of animal and plant origin, but in minute quantities. It is found in yeast, beef, liver, and kidneys in an insoluble form, but it occurs in a soluble form in vegetables and fruits.

The pathogenic significance of biotin is still unknown. Its involvement in several exchange processes (fat and carbohydrate) has been demonstrated. Some investigators think that a biotin deficiency reduces the number of erythrocytes and increases the cholesterol in the blood.

It has been tentatively estimated that man needs 0.15 mg of biotin daily.

Para-aminobenzoic Acid. Para-aminobenzoic acid is found in the liver of animals, yeast, mushrooms, and, in very slight amounts, in grain products. A para-aminobenzoic acid deficiency causes depigmentation of the hair and stunts the growth of experimental animals.

Folic Acid. Folic acid, like vitamin B_{12}, is known in clinical practice as a stimulator and regulator of blood formation. It possesses antianemic properties. It is noteworthy, however, that only free folic acid possesses vitamin activity. It is found in bound form in foodstuffs. Folic acid regulates the exchange of choline and participates in the formation of cholinesterase.

Folic acid is synthesized by yeast and certain microbes. The daily requirement of this vitamin has not yet been determined. It is believed to be about 2 mg. A therapeutic dose of folic acid once a day ranges from 5 to 50 mg. The maximum dose is 150 mg (S. M. Ryss).

Folic acid is found in yeast, liver, mushrooms, spinach, asparagus, and other vegetables.

It is now possible to enrich flour by adding synthetic vitamins to it before bread is baked.

We learned during World War II that the most valuable food supplement is yeast, which contains, besides the B-complex vitamins, a substantial amount of rich protein. Table 25 shows the amount of vitamins in baking and brewer's yeast.

TABLE 25

Vitamins	Vitamin content in mg per 100 of dried yeast	
	baking	brewer's
B_1 (thiamine)	2.0	5.0
B_2 (riboflavin)	3.0	3.6
B_6 (pyridoxine)	0.5	0.4
PP (nicotinic acid)	40-50	40-60
B_3 (pantothenic acid)	15-20	20

Cereal germ was fairly widely used during the war to enrich hospital food and the diet of convalescents. In grinding grain the germ is ordinarily discarded and used in raising poultry and cattle. During the war up to 50 g of cereal germ was added to the porridge served. It can be used for baking dietetic rolls, sponge cake, biscuits, etc.

The comparatively high vitamin content of animal liver makes this food a desirable item with which to enrich the diet. According to V. A. Devyatin, 100 g of raw beef liver contains about 30 mg of vitamin A, about 0.4 mg of thiamine, 3 mg of riboflavin, about 2 mg of pyridoxine, over 5 mg of nicotinic acid, and about 3 mg of pantothenic acid.

Vitamin B_{12}. Vitamin B_{12} plays a major role in several exchange processes, including the synthesis of nucleic acids and nucleosides needed for normal blood formation. It is involved in the synthesis of choline, the activation of coenzyme A which regulates fat exchange, and several carbohydrate exchange reactions. There are reasons for believing that vitamin B_{12} helps to improve utilization of the amino acids, decreasing their content in the blood and accelerating their incorporation in the protein molecule (V. N. Bukin).

In nature vitamin B_{12} is synthesized by microorganisms. It is apparently not produced in the cells of animals or plants. The microflora of ruminants synthesizes vitamin B_{12} in the presence of cobalt. A cobalt deficiency in the food of animals causes a serious disease called marasmus, which can be easily cured by vitamin B_{12} and cobalt administered orally, not injected subcutaneously or intramuscularly. Vitamin B_{12} is also synthesized in the human intestine. A vast amount of the vitamin is manufactured in the course of biological purification of sewage (active silt) and in cultivating actinomycetes during the production of antibiotics.

Vitamin B_{12} is successfully used to treat a variety of diseases: disorders of hematopoiesis, impaired liver function and nervous activity. It is particularly effective for Addison-Biermer's disease and other pernicious anemias of the megaloblast type.

Such animal products as beef, pork, veal, liver, kidneys, curds, and eggs are good sources of vitamin B_{12}.

Inositol. Inositol is found in foodstuffs of animal and plant origin. It is especially abundant in the internal organs of animals. In fruits and seeds inositol occurs in the form of phytin. The presence of inositol in food prevents fatty degeneration of the liver. The daily requirement for man has not been established. It is believed that about 1 g is sufficient.

Choline. This substance, classified by some investigators among the vitamins, may be synthesized in the organism. In foodstuffs choline is found in lecithin. A choline deficiency impairs fat exchange and causes fat infiltration of the liver.

Choline is the carrier of an easily split off methyl group CH_3. It serves as starting material to synthesize acetylcholine in the organism. It is fairly abundant in egg yolk, liver, brain, wheat germ, and milk.

The tentative choline requirement for man is 35 to 50 mg per kg of body weight.

Vitamin C. Vitamin C (ascorbic acid) plays a major role in the body. It participates in the oxidation-reduction processes and affects various body functions. It has recently been shown to influence carbohydrate and protein exchange. A vitamin C deficiency in the diet decreases the amount of sugar in the blood and glycogen in the liver, impairs the processes of nitrogen exchange, and accelerates the disintegration of protein in the organism. There are reasons for believing that ascorbic acid becomes part of the complex enzymes involved in cellular respiration.

It is also capable of forming self-oxidizable complexes with iron, an element widely distributed in the tissues (B. I. Gol'dshteyn).

Ascorbic acid is found in almost all cells and tissues, indicating that it must perform some important common biological function. Vitamin C is present in abnormal amounts in growing cells (malignant neoplasms, placenta) and in cell division (spleen). This is the basis for assuming that vitamin C plays a major role in growth and cell division.

Burns covering a large area of skin markedly decrease the ascorbic acid content of the adrenal glands, skin, liver, and muscles. After a burn the body uses up its vitamin C more sparingly. Additional ascorbic acid fed to experimental animals raises the level in the tissues and favorably affects its consumption after a burn. Enriching the diet with vitamin C improves the clinical course of burns and shortens the time of healing (M. F. Merezhinskiy, G. P. Taranovich, and V. A. Ivanova).

The antiscurvy properties of ascorbic acid are very important. A deficiency of vitamin C, chiefly in cooked food, leads to C-hypovitaminosis.

Prolonged vitamin C starvation causes scurvy, the main symptom of which is a tendency to bleeding. It reduces the resistance of the body to infections. C-avitaminosis is often accompanied by furunculosis, pneumonia, exacerbation of tuberculosis, and other diseases.

A major role in the development of a hemorrhagic diathesis is played by citrin or vitamin P, which is found with ascorbic acid in a number of foods. A lack of citrin in the diet weakens the walls of the capillaries and destroys their permeability.

The danger of C-avitaminosis is unusually great in the winter, due to the difficulty of obtaining vegetables, and in the spring, when the stores of vegetables are almost exhausted. It must be remembered that vitamin C deficiency ordinarily shows up as an indistinct hypovitaminosis. The latent forms of scurvy, which appear as weakness and ready fatigability accompanied by drawing pains in the extremities (chiefly in the gastroenemius muscles), capillary bleeding from the gums, and dryness of the skin, often have other causes. Oversight and the failure to take the necessary measures in time create the danger that genuine scurvy may develop with extensive hemorrhages in subcutaneous tissue and muscle belly, joint injury, swollen gums, and stomatitis.

We may conclude from observations made in the Far North that the initial symptoms of C-avitaminosis follow a definite pattern. First the lower extremities swell, then skin rashes and hemorrhages appear in the muscles, with gingivitis and hemorrhages under the skin developing soon thereafter.

Body temperature with C-avitaminosis is usually not high; in a rare case an elevated temperature may indicate a severe course of scurvy.

It is noteworthy that C-avitaminosis sometimes develops when there is about 0.5 mg% ascorbic acid in blood plasma. It may also happen that all the symptoms of scurvy disappear while the ascorbic acid content of the plasma remains at the 0.2 mg% level (V. Ya. Chekin).

According to P. F. Voronin, natives from the southern regions of the country exhibit a marked decrease of ascorbic acid in the blood and urine along with reduced resistance of the capillaries during the first four months that they are in the north. This is apparently caused by the peculiarities of vitamin C exchange in the north. That is why it is necessary to increase the daily allowance of ascorbic acid in the rations of southerners, for it eases adaptation to the new conditions.

When the body has an adequate supply of vitamin C, some ascorbic acid is excreted with the urine. According to G. Ye. Vladimirov and other investigators, the amount of vitamin C in the diet may be regarded as sufficient only if at least 25 mg of ascorbic acid is excreted daily with the urine. A vitamin deficiency is indicated by 10 mg of ascorbic acid in the daily portion of urine.

The vitamin C requirement ranges from 50 to 100 mg depending on the work performed: (1) moderate - 50 mg; (2) heavy - 75 mg; (3) very heavy - 100 mg.

Natural conditions in the Far North require that the daily dose of vitamin C for an adult be increased to 75 to 100 mg. The ascorbic acid content of foodstuffs must therefore be carefully checked in order to make good any insufficiency by adding vitamin preparations or utilizing wild-growing polar plants.

The main sources of vitamin C in army rations are cabbage and potatoes. In dried form along with carrots they supply vitamins of the B complex and nicotinic acid.

Vitamin C is very common in nature. It is found in fresh vegetables, fruits, berries, and greens. Substantial amounts, it was recently discovered, occur in the leaves of uncultivated plants: lime, birch, alfalfa, rowan, buckthorn, etc. The hip-bearing rose, unripe walnuts, black currants, cabbage, potatoes, tomatoes, spring onions, sorrel, nettles, strawberries, raspberries, and cloudberries are especially rich in vitamin C. However, such common berries in the Soviet Union as red bilberries, cranberries, and cowberries contain virtually no vitamin C. The same is true of cereals and legumes (rice, wheat, barley, peas, buckwheat, oats) in which vitamin C is found only during germination.

The amount of vitamin C in milk (Figure 48) is an indicator of the vitamin C activity of plants used as cattle fodder.

Retention of Vitamin C in Cooked Food. Vitamin C is destroyed during the cooking process, being oxidized to dehydroascorbic acid — an unstable compound. This compound is easily destroyed by heat; it is completely destroyed within five minutes when the pH is 5.0 (with higher pH the destruction takes place more quickly).

The enzymes ascorbinase and phenolase and the ions of heavy metals (chiefly iron and copper) function as catalytic agents of oxidation. Copper acts catalytically in a concentration of 3 to 5 mg%. This concentration of copper ions is even found in tap water. Iron acts as a catalyst only in an acid medium. In an alkaline medium the oxidation of ascorbic acid is catalyzed by hydroxyl ions.

According to Ye. A. Krayko, more ascorbic acid is destroyed at a temperature of 60° than at 100°. If cabbage is immersed for 30, 60, and 90 minutes in water heated to 60°, 54, 45, and 33%, respectively, of the ascorbic acid is retained. If the cabbage is immersed in 98° water, 70, 60 and 58%, respectively, of the ascorbic acid remains. The higher percentage of vitamin retention in boiling water is attributed by the author to deactivation of the oxidizing enzymes at the boiling point.

According to N. S. Yarusova, if cabbage is cooked for an hour and then immersed in boiling water to which the original water has been added, 80% of the ascorbic acid remains in the cabbage (initial concentration about 10 mg%).

Cabbage cooked for 20 minutes and immersed in boiling water retains all of its vitamin C if the weight proportion of the cabbage to the water is as 1:2 (G. L. Derkovskaya-Zelentsova).

According to D. S. Buyanovskiy, a cooked peeled potato retains more vitamin C if immersed in boiling water.

Under these conditions 85% of the original amount of ascorbic acid remains as against 77% in the first case.

Proof of the destructive effect of air is seen in the better retention of vitamin C in soups when cooked in pots with lids. For example, when cabbage soup is cooked under industrial conditions for an hour, 60% of the vitamin C remains after it is kept for three hours; if cooked in saucepans with covers, 92% remains after the same length of time (G. L. Derkovskaya-Zelentsova).

M. L. But showed that cooking and keeping soups hot (for two hours) in large pots half full sometimes results in total destruction of vitamin C; in pots filled to the top about 88 to 100% of the vitamin C remains under the same conditions.

There is a considerable loss of vitamin C in cooked food kept hot for three to six hours.

The minute amounts of copper that pass into cooked food from pots and kitchen implements help to destroy vitamin C. The catalytic effect of copper is more pronounced at 50 to 60° than at the boiling point. V. V. Meybaum says the reason is that oxygen is not present in liquid food while it is being boiled.

Tests of the effect of aluminum pots on the retention of vitamin C in cooked food have shown that 40 minutes of boiling followed by keeping the food at 75° for two hours result in the total destruction of ascorbic acid. This may be due to the action of the copper in the aluminum vessel. It is noteworthy that a 5 mg% concentration of the vitamin is less stable than a 10 mg% concentration. With identical surface of liquid, the larger vessel retains more ascorbic acid.

Vitamin C keeps better in an acid medium; an alkaline reaction destroys it.

The amount of vitamin C in cooked and uncooked foods is set in accordance with the instructions of the Main Military Medical Administration, Ministry of Defense, and the State Research Institute of Vitaminology, Ministry of Health, USSR.

Stabilizers of Vitamin C. The stabilizers of vitamin C include primarily substances forming complex compounds with copper where copper is scarcely ionized and does not react with ascorbic acid (N. A. Bryukhanova). The commonest stabilizers are proteins, amino acids, glutathione, cysteine, and sodium chloride.

According to S. I. Vinokurov, the phytoncides of onions, garlic, horse-radish, and some other vegetables inhibit the oxidation of ascorbic acid in the presence of copper. If the vapor of an aqueous extract of onions is trapped by a solution of ascorbic acid (in a 17 mg% concentration), the vitamin survives for three days. In a control solution it is completely oxidized in a day.

Baking yeast also stabilizes vitamin C. This may be due to the presence of glutathione and vitamin V_1 in the yeast. Many investigators (A. A. Titayev, Z. Gershenovich and A. Minkina) have demonstrated the inhibition of the oxidation processes of ascorbic acid. Titayev's data indicate that vitamin B_1 can hinder the oxidation of ascorbic acid by ascorbinase.

Many foods that are capable of reducing the diffusion of oxygen from the air and weakening the effect of the copper ions are other vitamin C stabilizers, for example, sugar, which acts during an acid reaction (Ye. F. Shamray), and starch (N. A. Bryukhanova). A layer of grease on a dish helps to retain vitamin C (S. I. Vinokurov).

Vitamin C is also stabilized by starchy and protein products: barley flour - 67% retention, oat - 66%, wheat - 46%, rye - 35%, powdered egg - 60%, cottage cheese and egg white - 54% (N. A. Bryukhanova). A single egg added to potato soup stabilizes the ascorbic acid.

V. V. Meybaum dissolved ascorbic acid (17 mg%) in tap water, boiled it for 50 minutes, and then kept it for three hours at 70 to 75°. He obtained good results as far as retention of the vitamin C was concerned (with the addition of soy and buckwheat flour - 52.7%, rye flour - 41.9%, semolina - 34.1%). Only 14.9% remained in the control solution. Meat and soy flour in the cooking of potato soup likewise exerted a stabilizing effect on vitamin C (without meat - 63% retention, with meat - 93.2%).

The pH of the medium plays a major part in the retention of ascorbic acid. Sodium chloride, for example, exerts a stabilizing effect when the pH ranges from 3.7 to 4.0 (10 mg% concentration of vitamin C).

K. Tikotskaya produced a stabilizing effect in experiments with aluminum, which is destructive to ascorbic acid. Some 45 to 70% was retained in the presence of fresh cabbage, sauerkraut, tomatoes, tomato paste, onions, garlic, carrots, sorrel, or meat.

Thus, there is no basis for the prevalent view among army doctors that an acid reaction is vital for the retention of vitamin C in cooked food. Recent research has shown it is determined by the interaction of a number of destructive and stabilizing factors.

The practical conclusion to be drawn from all this by those charged with supervising the feeding of soldiers is that the destructive substances should be replaced with suitable stabilizers. The result will be retention of vitamin C in the food and enhancement of its value.

Enrichment of Food with Vitamin C. Soups may be enriched with vitamin C by adding to them young nettles, mountain spinach [orach], or beet tops. The bitter aftertaste of radish tops and the green leaves of cabbage can be removed by immersing them for some time in hot water and then discarding the water. The improved taste makes up for some of the loss of vitamin C.

Red pepper, cauliflower, and horse-radish are particularly rich in vitamin C. The sprouts of peas and beans are effective against scurvy if consumed at the rate of 150 g a day. The peas are first soaked for 20 to 30 minutes at a temperature of 15 to 18^{o} in a wooden, enameled, or aluminum pot and then placed on a clean table covered with damp sheets or on cheese cloth stretched over wooden frames. The peas are piled up 2 to 3 cm high and covered with a damp sheet. Sprouting ends in 72 hours. The peas are stirred around every five or six hours for better aeration. Sprouted peas have 20 to 25 mg% ascorbic acid. They may be eaten raw or used as a garnish for various foods.

Rice sprouting in four days is another good remedy for scurvy. It may be eaten as a salad (200 g) or porridge after being mashed with a knife or passed through a meatgrinder.

An infusion of dried currants is made from washed berries scalded with boiling water in the proportion of one part berry to three parts water. The resultant infusion is squeezed through cheesecloth and given to patients in the morning and in the evening.

5 to 10 g of hip-bearing roses contains enough vitamin C for a daily portion for one person. The dried fruits are washed and crushed and made into an infusion. It is then poured into a tea kettle and boiled at the rate of 5 to 10 g of fruit per glass of water. Several layers of cheesecloth or closely woven cloth are tied around the spout of the kettle.

The swollen hips passed through a sieve can be made into a puree to be added to borshch and other soups, fruit jelly, and compote. Rose hips contain carotene (provitamin A) in addition to ascorbic acid.

When vegetables are difficult to procure, it is necessary to make extensive use of pine needles and leaves in preparing vitamin infusions directly in a military unit.

Gladiolus leaves are a rich source of vitamin C, containing 600 to 900 mg%. The best way to obtain the vitamin is to steep cut and slightly rubbed leaves in boiling water in the proportion of one part leaf to three parts water. Within an hour there is an agreeably tasting liquid containing 300 mg of ascorbic acid per 100 ml of infusion.

In the north rowanberries warrant special attention because they contain 40 to 60 mg% vitamin C, i.e., as much as lemons and oranges. These berries are also rich in carotene (10 to 12 mg% in fresh berries and 20 mg% in dried berries). They are superior to carrots in this respect.

It has been known for a long time that pine needles have antiscorbutic properties. A. M. Kirkhenshteyn pointed out that Latvian peasants have always added young pine shoots to their food. In 1775 a book came out in Yelgava on the treatment of scurvy. The book mentioned that during the Russo-Swedish War of 1708-1709 scurvy among the soldiers was successfully treated with infusions made from pine needles, which were also used as a preventive. Pine needles (in the central belt of Russia) contain from 150 to 250 mg% ascorbic acid, over 350 mg% in the north. The needles are richest in the vitamin during the winter — from November to March; in July and August vitamin activity is least. Fir needles contain 150 to 250 mg% vitamin C in the winter and 75 to 150 mg% in the summer. Old shoots are three times richer in vitamin C than young shoots. Seasonal changes in vitamin C activity of coniferous needles are shown in Figure 49. The storing and processing of the needles is complicated by the fact that they possess ascorbinase, which oxidizes vitamin C. That is why infusions should be prepared chiefly from freshly cut branches of the trees.

Many ways of preparing vitamin infusions from coniferous needles were developed during World War II, the best being those of Professor Pyatnitskiy and of the Soviet Army's Research Institute of Experimental Sanitation. Vitamin infusions obtained by these methods meet three basic requirements: (1) high vitamin activity; (2) acceptable taste (no bitterness); (3) capability of being stored for a long time without loss of vitamin potency.

Vitamin infusions can be prepared in the spring and summer from birch and linden leaves and from alfalfa. Since the leaves wither quickly, it is not recommended that they be stored. Fresh green (not yellowed) leaves should be used the same day. If this is impossible, the leaves should be put in a cool place protected from the rain and sun and stored for more than two days.

If no fresh vegetables, beet tops, or wild-growing greens are available, infusions and concentrates must be prepared from coniferous needles and birch, linden, and alfalfa leaves. In the event that this too is impossible, military units and hospitals are supplied with vitamin preparations: (1) vitamin C tablets containing 50 mg of ascorbic acid each; (2) tablets and vitamin CB_1 bonbons containing 50 mg of ascorbic acid and 2 mg of thiamine (vitamin B_1). For therapeutic purposes a 5% sterile solution of ascorbic acid is injected subcutaneously or intravenously. Between 300 and 1,000 mg of ascorbic acid a day is prescribed for scurvy.

Vitamin P (Citrin). A lack of vitamin P or citrin results in the development of a hemorrhagic diathesis accompanying scurvy. It has been demonstrated that vitamin P affects the condition of the capillaries — their strength, elasticity, and permeability.

The sterilization of foodstuffs is based on the effect of high temperatures that halt the development of microorganisms. Most of the vegetative forms die at 60°. Some species withstand heat up to 70 or 80°. A. V. Reysler's data indicate that 99.85% of the microorganisms die after 20 minutes of 65° heat. Spore forms can withstand 20 minutes of 125° heat.

Foods packed in glass jars or tin cans may be sterilized. Sterile, hermetically sealed canned meats, fish, and vegetables can under certain conditions be stored indefinitely.

Stewed meat is the principal type of canned meat used by the army. The cans are sterilized at a temperature of 113 to 120°. They are kept in a thermostat for ten days at 37° for the purpose of bacteriological control. If the cans swell as a result of the multiplication of microorganisms or spores, the batch is destroyed. Out of the batch that pass the thermostat test one jar is selected per autoclave change and analyzed. If the causative agents of botulism or other pathogenic microorganisms are found, the entire batch is held up. The State Sanitary Inspection cooperates in deciding whether these cans are usable. If nonpathogenic spore-forming anaerobes are found, the food is released, provided that it satisfies all the other requirements (A. M. Kazakov).

Pasteurization of milk, fruit and vegetable juices, etc.,is not common in army practice. Not long ago pasteurized bacon and lard were added to the rations. There are two kinds of pasteurization: prolonged - at 63 to 65° (an hour) and brief - at 75 to 90° (several minutes).

Drying is a very old army method of preserving food. Dry food containing less than 15% moisture lacks the conditions favorable to the multiplication of microorganisms. The Soviet Army makes extensive use of drying to preserve vegetables and fruits and to make crackers and powdered milk. Powdered butter, cream, tomato concentrate, potato flakes and other items with a moisture of from 3% (butter) to 5% (potatoes) have recently been made available.

Meat products are not dried, nor are the troops supplied with powdered meat. However, drying as a method of preservation has some practical significance. Army doctors are familiar with the fact that bread crust in a carcass prevents microbial insemination of the meat and inhibits the development of microflora. The reason is that a certain amount of moisture in the substrate is necessary if the microorganisms are to multiply.

Due to recent improvements in the technology of dehydration this method is used to preserve meat and sausage. The most important chemical method involves the use of table salt, which removes water by changing the osmotic pressure, thus inhibiting development of the microorganisms. The chlorine ions have an effect at the same time. It has been demonstrated that a 10% solution of sodium chloride halts the growth of microorganisms of the intestinal group and the causative agents of botulism.

Salting causes a reduction in nutritional value due to the loss of some of the food. In addition, there is a deterioration in its organoleptic properties.

It wasn't too long ago that salting was the chief method of preserving easily spoiled meat and fish. Corned beef is no longer eaten and salted fish has been replaced by frozen fish.

The Soviet Army has recently begun to pickle carrots in concentrated salt solution as a source of carotene.

Sulfitization is rarely used.

Sodium benzoate is used as a preservative for apple sauce and some half-cooked fruits and berries (no more than 0.1%).

Benzoic acid (0.07%) is used as a preservative for margarine.

Cabbage may be fermented by lactic acid. This method is based on utilization of the bacilli of lactic acid fermentation that convert sugar into lactic acid. The acid acts as a preservative, inhibiting growth of the microorganisms. The salt used to pickle cabbage halts the development of foreign microflora.

Curing involves the combined effect of salting, drying, and the antiseptic action of smoke containing formaldehyde, creosote, phenol, and other substances.

Marination is based on the use of acetic acid, which inhibits the multiplication of microorganisms.

Neither of the above methods is commonly used in the army.

Food Concentrates

In recent years the Soviet Army has been extensively using food concentrates, which make it possible to feed efficiently isolated soldiers and small units operating by themselves. These concentrates are particularly necessary owing to the difficulty of providing fresh food under the conditions of a modern war. It is difficult to conceive of how raiding rifle, ski, and tank units or parachutists could be supplied without using food concentrates.

The general requirements of these food concentrates are: (1) maximum caloric value in a unit of weight or volume; (2) conformity with established content norms of proteins, fats, carbohydrates, mineral salts, and vitamins; (3) individual packing for the different items; (4) good taste; (5) capability of being stored for a long time and portability in the field; (6) rapid (10 to 15 minutes) preparation of an item for individual or group consumption.

The concentrates are made from high quality foods without the addition of any substitutes. During the preparatory process the items are brought to a state of half-readiness by briquetting. They are made fully ready by returning to the briquette the water removed from it (0.6 to 0.7 liters per portion of the first course [soup] and 0.3 to 0.6 liters for the second [meat]) and heating the resultant mixture for 15 to 20 minutes.

Concentrates are not sterilized nor are they canned food in the narrow sense of the term. Therefore, the length of time they can be safely stored depends on a variety of circumstances. Concentrates must be protected against dampness and humidity (over 80%). Special care must be taken to keep rodents and insects out. Experience shows that most of the concentrates used by the Soviet Army can be stored for 1/2 to 1 year: pea soup - 1 year, millet porridge - 6 months, buckwheat porridge - about 4 months.

According to V. L. Gnoyeva, concentrated millet porridge and dried cooked carrots are unusable after three months of storage because of marked deterioration of their organoleptic properties. Dried cooked potatoes, on the other hand, taste good even after five years of storage.

Concentrated groats usually become spoiled as a result of hydrolytic disassociation and rancidity of the fat (either added in preparing the various foods or contained in the groats).

Concentrated peas, soy beans, and lentils can be stored for a year. If the peas are roasted and the soy flour deodorized (the enzymes inactivated), the concentrates are more stable and can be stored for longer periods of time.

N. F. Marker's data show that concentrates remain tasty if the fat is acid: (1) in pea soup or puree - up to 7 mg KOH; in soy soup or puree up to 5 mg KOH. If there is a further increase in acidity, the concentrates must be consumed promptly.

10 to 15% soy (deodorized) flour or 10 to 20% pea flour may be added to the least stable concentrate (millet porridge) as an antioxidant.

In appraising concentrates one must be guided chiefly by the data obtained from organoleptic examination and moisture content. The amount of water in concentrates must not exceed 12%. Some idea of the quality and condition may be obtained by determining the acidity of the fat. In this connection it is essential to know the precise kind of fat used in preparing the concentrate (suet, lard, margarine, etc.). The total acidity in concentrates usually rises in the course of time and is an indirect indicator of poor quality. It is tentatively held that the acidity of pea soup or puree ought not exceed 9°, borshch from dried raw vegetables - 5°, millet porridge - 1°, buckwheat porridge - 3.2°.

Vegetables

Vegetables play an exceptionally important part in the diet of soldiers. They constitute the main source of vitamins (carotene, ascorbic acid, etc.) and mineral salts, including microelements. Vegetables make for variety and improve the taste of foods. Their cellulose is needed to provide adequate roughage. It also largely determines the nature of the intestinal microflora.

The vitamin content of fresh vegetables varies with their quality, place of growth, degree of freshness, and storage conditions. In fermented vegetables it depends on the method of pickling and storage conditions. Well fermented and properly stored cabbage is virtually indistinguishable from fresh cabbabe in ascorbic acid content. The amount of ascorbic acid in fresh vegetables decreases with time. The so-called leafy vegetables (lettuce, sorrel) and beet tops are particularly unstable owing to the presence of the enzyme ascorbinase, which promotes the oxidation and destruction of ascorbic acid. That is why these vegetables must be promptly cleaned and cooked as briefly as possible. The sharp decrease in vitamins due to changes in the daily diet can be judged from the data presented in Table 26.

TABLE 26

Foodstuffs	Vitamin content, in mg				
	A	B_1	B_2	PP	C
Full variety of foods	4.00	2.10	1.40	19.0	44.0
Full variety of vegetables	3.60	0.52	0.67	5.7	40.4
Substitution of potatoes for carrots	0.17	0.52	0.67	6.0	42.0
Substitution of potatoes for all the vegetables	0.16	0.57	0.33	8.2	30.7
Substitution of groats for all the vegetables	—	0.33	0.23	4.2	—

If potatoes are substituted for carrots, there will be scarcely any vitamin A in the daily ration. The substitution of groats or dried vegetables for fresh vegetables is particularly undesirable, for the diet will then lack vitamins A and C.

The best way of keeping fresh vegetables is to freeze them at -18 to -24°. Quickly frozen vegetables retain their taste and vitamins. Such vegetables can be transported only in refrigerated conveyances or isothermic containers which prevent thawing. The vegetables are prepared by removing them from the packages and immersing them in hot water.

Rock salt is used to prolong the period of storage of carrots. Some 25 kg of salt is applied per 100 kg of fresh carrots. Pickled carrots and brine contain about 18% salt. The low freezing point of brine (-20°) makes it possible to store the carrots in unheated warehouses. Pickled carrots have about the same amount of carotene as fresh carrots.

Pickled vegetables have long been used in the army as stock for cabbage soup, borshch, and vegetable soup. Dried vegetables are issued in the form of briquettes packed in hermetically sealed tin cans. The

drying process reduces the vitamin activity to a greater or lesser degree depending on the method used. A good deal is retained if the vegetables are dried quickly in a vacuum. Ascorbic acid is the most easily destroyed; carotene and the B-complex vitamins are more resistant to heat.

In a modern war it is very important for the troops to have vegetables, fresh or fermented, to which fat, tomato paste, salt, sugar, and spices have been added. The vegetables can be vitaminized with a puree of sweet red pepper. It also helps to speed up the cooking — a few minutes (exclusive of the time it takes to boil the water) instead of three to four hours. Where circumstances do not permit the lighting of a fire, boiling water may be poured over the canned vegetables, which can be eaten 13 to 20 minutes later.

It is hygienically important that the vegetables be packed in glass jars or tin cans, thereby safeguarding them from contamination by poison gas, radioactive substances, pathogenic microorganisms, or toxins. Decontamination, degasification, or disinfection of hermetically sealed jars is very easy and there is correspondingly less danger of infection during the process of preparation.

The Soviet Army has various kinds of vegetable dishes: cabbage soup, borshch, pickled cucumber soup, sour cabbage and fish, etc. Stewed cabbage is used in cooking cabbage soup, borshch, stews, and garnishes along with relishes containing sauteed carrots, onions, and tomatoes.

Medical Supervision of Baking

If there are no civilian bakeries near a military post, the army bakes its own bread. In wartime the troops are supplied with bread from mobile bakeries and motorized field bakeries (PAKh). Bread baking is supervised by the medical service of the Soviet Army. Medical personnel inspect the places where the bread is baked as well as the materials used (flour, salt, water, yeast, leavening).

The bread forms are greased with an emulsion of vegetable or mineral oils. An emulsion of vegetable oil is obtained by dissolving 4 g of soda ash in one liter of warm water and adding one liter of vegetable oil. A mineral oil emulsion is made from an alkaline solution consisting of 6 kg of oil per 4 liters of filtered alkali obtained from 1 vedro [12.299 liters] of ash and 2 vedros of water. The mixture is steeped two to three hours and filtered.

Neither the alkali and soda ash solution nor the emulsion should be stored in a zinc vessel.

Dough loses weight while the bread is being baked. This loss is expressed as a percentage, ranging from 7 to 12%, depending on the quality of grain, size of loaf, oven design, and other factors.

The expression "weight change" is the difference between the weight of the bread when it cools and the weight of the flour used in the baking. The percentage of weight change is determined from the following formula:

$$\text{weight change} = \frac{\text{weight of bread in kg} - \text{weight of flour in kg}}{\text{weight of flour in kg}} \times 100$$

The health significance of weight change is found in its relation to the food value of the bread. A substantial change indicates an excess of water in the bread and less calorie value. Hard bread with low moisture content has slight porosity and is less assimilable.

Here are the established norms of weight change (as a %) for loaves of bread from army bakeries:

Rye bread from cleaned flour	55
White bread from cleaned flour	49
Rye-wheat bread from cleaned flour	37
White bread from top quality flour	34

If the moisture of the flour is decreased, the rate of weight change rises, and vice versa.

Bread may be rejected because of defects in the external appearance of the loaves or soft part of the bread (uneven porosity, half-baked portions, insufficient kneading, lumps of salt, hardening). The troops are not furnished bread with a persistent odor or bread that is bitter or sweetish, or baked from sprouted grain.

All those working in bakeries are first given a medical checkup. They are examined every six months as possible carriers of bacilli or worms as part of the clinical checkup. All those showing symptoms of intestinal or venereal diseases, pyodermas, open forms of tuberculosis, or other infectious diseases are immediately removed from their jobs. No one who has recovered from an acute intestinal infection may work in a bakery until he has been found to be free of bacilli. The feldsher attached to a bakery must strictly enforce the regulations on personal hygiene for all bakers and helpers. Bakers must shower daily and change their working clothes at least twice a week. Weekly medical checkups are a necessity.

Improving the quality of bread. Bread is a staple both of the civilian and the army diet. In the latter bread provides 44% of the daily calories, 37% of the protein, 8% of the fat, and 55% of the carbohydrates. In addition, it supplies 1.2 mg of vitamin B_1, about 0.7 mg of riboflavin, and 30 mg of vitamin PP, 250 mg of calcium, 1,440 mg of phosphorus, and 16 mg of iron. This means that bread takes care of a substantial part of the vitamin B_1 and PP requirement and the daily adult needs for phosphorus and iron. Bread contains little fat (8% of the daily norm) and calcium (25% of the daily norm). It lacks an essential amino acid — lysine — and vitamins A, C, and D. Its vitamin B_2 content (0.7 mg) scarcely covers half of an adult's daily requirement (3 mg).

V. L. Kretovich suggests that the food value of bread can be enhanced by: (1) raising the flour yield so as to include all parts of the aleurone layer and germ, which are richest in minerals, vitamins, and proteins; (2) adding bran to the top grades of flour after first

treating them to increase assimilability; (3) enriching the top grades of flour with vitamins, amino acids, and minerals; (4) including in flour natural substances that are rich in minerals and proteins (yeast, soy flour, oil cakes, cereal germ, powdered skimmed milk, etc.).

Bread that is slow to get stale. Bread, of course, begins to get stale 10 to 12 hours after it is baked. If the air is humid and ventilation poor, bread may get mouldy. Well baked bread can remain fresh for two or three days if properly kept.

Bread that is slow to get stale is particularly important during war. The Soviet Army uses three ways of making this kind of bread: (1) rye or rye-white bread that can keep for a long time in a soft multilayer wrapper; (2) canned bread from top-quality flour; (3) rye and rye-white bread that keeps briefly in a three-layer wrapper.

Long-lasting rye and rye-white bread is baked in the usual way from leavened dough and kept 20 to 24 hours, then cut into slices 15 to 20 mm thick, and covered with five layers of wrapping material: wax paper, aluminum foil, two layers of cellophane, and thick wrapping paper. The folds and seams of the wrappers are stuck together with a glue made from polyvinyl alcohol. The bread is then sterilized for 4.5 to 5 hours at 100 to 110° after which it is dipped in melted paraffin for better sealing of the wrapper.

The moisture content and acidity of sterilized bread must not be in excess of 47% and 11°, respectively (10° for rye-white bread).

Sterilized bread can be kept two months or more. If wrapped in moisture-proof cellophane, it lasts four to five months.

Slow-staling bread can be eaten cold or freshened up. It is freshened in hot-air closets at 130 to 150° for 1.5 to 2 hours.

Tinned bread is made from high-grade flour. The cans are half filled with prepared dough weighing 400 g. The insides are first smeared with vegetable oil or covered with a special lacquer.

After the dough has risen to occupy 80% of the space, the cans are covered and rolled by machine. The bread is baked and then sterilized in an autoclave under a pressure of about 2.5 atm. The moisture of the bread is 40%, porosity 65%.

Tinned bread can be kept for more than a year. It is eaten cold or freshened up (heated at 100 to 120°). The tins are placed in boiling water for 20 minutes.

As soon as regular rye or rye-white bread is baked, it is placed in three-ply paper packages which are first laid in cardboard or wooden boxes. The openings of the packages capable of holding six to nine loaves are hermetically sealed. The boxes are piled up and covered with canvas for three or four hours.

Each loaf may be wrapped individually (when hot) in three layers of paper, the openings closed with paper tape. The loaves thus wrapped are again placed in the oven for 60 or 65 minutes more of sterilization at 110 to 115°.

Bread that is slow to become stale is extremely important in a modern war because it is protected against poison gas, radioactive and bacterial aerosols by its good wrapping. Decontamination and degasification of the bread boxes practically eliminates the possibility of infection. When there is a danger of bacterial or radioactive contamination, the wrappings must be removed very cautiously.

The Effect of Ionizing Radiation on Foodstuffs

Ionizing radiation may cause more or less profound physico-chemical changes in foodstuffs depending on the dose: oxidation and reduction, disaggregation of high molecular compounds, deamination of nitrogenous substances, decarboxylation, polymerization and depolymerization, hydrogenation and dehydrogenation. It is noteworthy that the biological changes observed in pure foodstuffs do not always occur in complex food products owing, no doubt, to the protective role played by various chemical substances and their compounds.

Induced radioactivity may be found in foods as a result of neutron flux. Neutrons are formed in an atomic blast by the nuclei of the charge material (uranium or plutonium). The nuclei of certain radioactive fragments are another possible source of neutrons.

The nuclei of all the atoms of the substances composing foodstuffs are capable of capturing neutrons and forming radioactive isotopes possessing beta or beta-gamma activity. Induced activity may be found inside food as well as on the surface. The level of this activity ordinarily is not high and it does not exceed the maximum permissible hygienic limits. Bread and, in particular, salt are exceptions.

Induced radioactivity presents a certain danger only in the first few hours after an atomic explosion. The reason is that artificially radioactive isotopes formed by the neutron flux have a brief half-life of only a few hours. In addition, the quantity of radioactive isotopes decreases sharply beyond a radius of 1 km (with a nominal atomic bomb).

It is well known that alpha and beta particles are disseminated in the air for short distances. Consequently, when an atomic bomb or shell explodes, food will be affected by the neutrons and highly penetrating gamma rays. It is very important for the hygienist to study the effect of neutron flux and gamma radiation on all kinds of food.

Research has shown that gamma irradiation effects rapid changes in fish, meat, and animal and vegetable fats, slower changes in flour.

A substantial portion of the army rations containing meat, fish, and fats would inevitably be changed if exposed to neutrons and gamma rays, the extent varying with the total dose of gamma radiation and neutron flux.

Increased acidity of fat, formation of peroxides, and accumulation of ketones and aldehydes are observed in vegetable and animal fats after a dose of 300,000 r. Meat and fish exhibit a shift in the pH of an aqueous extract toward the alkaline along with increased amounts of ammonia.

No changes have been noted in rye and wheat flour irradiated with doses of 450,000, 700,000, and 950,000 r.

A dose of 100,000 r causes changes in the vitamin content of irradiated potatoes, sauerkraut, carrots, tomato paste, and flour. Potatoes and sauerkraut lose 15 to 30% of their vitamin C. Flour irradiated with a dose of 150,000 r retains only half of its vitamin B_1 (G. M. Yegiazarov). Carotene in carrots is more resistant to irradiation.

Irradiation sometimes alters the organoleptic properties of foodstuffs. A dose of 450,000 r changes the color of vegetable and animal fats. A disagreeable odor comes from meat and fish after a dose of 950,000 r. In bouillon made from meat cubes the fat thickens into flakes.

Research has shown that gamma radiation has a much weaker effect on food products than it has on pure foodstuffs (carbohydrates, proteins, fats). It is a fair conclusion that the former possess substances capable of blocking active atoms and radicals formed by high-energy radiation.

Certain irradiated foodstuffs (fats, flour) are not as readily stored as in their non-irradiated form. A month after sunflower oil is irradiated with a dose of 450,000 r, the acid number more than doubles, the peroxide numbers more than quadruple. The gamma rays evidently destroy some constituents of fat (mainly the tocopherols).

Changes observed in stored flour are caused by fat hydrolysis.

Changes in the quality of irradiated foods determined experimentally must by hygienically investigated and organoleptically appraised before they are supplied to the troops.

The need of systematic observation and laboratory control of the condition and quality of foods irradiated at the time of an atomic blast is also quite apparent. These foods must be stored away from non-irradiated foods and supplied to the troops first (with mandatory laboratory control).

In a war there is also the possibility of cattle becoming contaminated by radioactive substances when they pass through a contaminated zone. Aerosol contamination is another danger if the herd is covered with a radioactive cloud. The animals may also become contaminated by eating grass, hay or other fodder containing radioactive fallout or by drinking water from contaminated sources.

In all such cases the question of whether the animals can be used for meat will have to be answered after consultation with medical personnel following monitoring. Meat obtained from cattle that have been in a contaminated area must be monitored. The hides of contaminated animals are not processed until radiation activity has been brought down to permissible limits. Hides heavily contaminated by long-lived radioactive substances are destroyed.

The extent to which foods may be contaminated by radioactive substances varies with the nature of the items and the way they are wrapped. The wrapping of foods not protected in shelters will almost certainly be torn and the contents contaminated.

Contamination by radioactive dust or fallout of radioactive precipitation is especially dangerous. Food can become contaminated while it is being transported through a contaminated area unless packed in hermetically sealed, dust- and moisture-proof containers.

All food contaminated by radioactive dust or precipitation, especially after fallout of combat radioactive substances, must be given a careful radiological check. If the level of contamination exceeds permissible limits and decontamination fails to produce the expected results, the food is stored until radioactivity diminishes. Loose or liquid foods may be used only after they are carefully mixed with non-contaminated products. The activity of a mixture of contaminated and non-contaminated fat products must not exceed permissible limits.

Heat radiation produced at the time of an atomic blast 3 km from the epicenter of a nominal bomb explosion inflicts injuries on animals that require careful treatment. Animals in regions close to the epicenter will undoubtedly be severely burned. Secondary injury will be inflicted by hot fragments. Cattle can be expected to develop keloids.

Well-wrapped foods are not likely to be much affected by the flash since the high temperature doesn't last long nor does it penetrate deeply. Foods stored in shelters do not suffer from heat radiation.

Observations made in Japan led to the discovery that thick paper and wood are ignited by heat radiation at a distance of 3.5 km from the epicenter. There is little doubt that heat rays will incinerate wooden and paper containers of food unless it is kept in underground storehouses.

Decontamination of Foods

In time of war foods may be safeguarded from radioactive contamination by: (1) storage in underground areas with secure ceiling and hermetically sealed entrance impervious to radioactive aerosols; (2) airtight, moisture- and dust-proof wrapping of the items; (3) covering them during transportation with canvas or using covered trucks. Canvas placed over foods is helpful in preventing radioactive contamination whenever they have to be shipped or stored (except in well equipped warehouses).

The best way to protect food from radioactive contamination is to use glass or metal containers. Various kinds of plastic containers are also effective. Burlap is the worst kind of material to use. However, it is fairly satisfactory for dry items if used in double layers with polyethylene in between. Wooden boxes should be lined with wax paper, cellophane, or polyethylene.

Foods exposed to radioactive substances are divided into four groups depending on the degree of activity: (1) non-contaminated; (2) contaminated below the permissible level; (3) contaminated above

Foods may be conveniently divided into four groups depending on the extent of contamination: (1) strongly contaminated by liquid gas; (2) moderately or slightly contaminated; (3) exposed to vaporous gases; (4) suspected of contamination.

The first group is destroyed, the second degassed, the third aerated. Laboratory tests indicate whether the fourth group is to be treated.

The depth of gas penetration is taken into consideration when determining the degree of contamination. Liquid gas is known to penetrate grain and groats to a depth of 5 cm, but flour only to 2 cm. Gas goes twice as deep in burlap. Solid fats and oils are contaminated to a depth of 3 cm, meat 1.5 to 2 cm. Food in glass, tin, or plastic containers can be regarded as safe. Wax paper, cellophane, and thick paper are quite effective in protecting food from gas contamination.

In a war the main attention is focussed on safeguarding food from gas contamination. This requires the construction of airtight shelters and covering the food with two layers of canvas. Special transportation facilities equipped with canvas are used for shipping the food. The food is packed in boxes lined with at least two layers of thick paper. Items in burlap bags, in storage or in transit, are kept under canvas. Field kitchens are placed under sheds or in earth shelters while thermos bottles are covered with canvas or thick paper.

The complex problems involved in safeguarding and degassing food requires a well organized gas detection system to determine the kind of gas used and extent of contamination of an item as well as to check on the completeness of degasification. Gas may be detected in the field with the aid of special equipment or in laboratories to which samples of food are sent.

Cattle passing through a contaminated area may become affected in the legs and respiratory and digestive organs. Their whole system may become affected if they eat contaminated fodder. The animals then have to be degassed. After slaughter the most contaminated parts of the carcass (legs, lungs, stomach, and intestine) are destroyed. The hide may be used after it is degassed. The meat is tested before use.

Animals may not be slaughtered if their temperature is elevated because it indicates serious gas injury.

Food Poisoning

There are two types of food poisoning: (1) food toxinfections and (2) food intoxications (chemical and bacterial - botulism, staphylcoccal intoxications).

Food Toxinfections. These include diseases marked by swift onset of temporary infections, with sharply pronounced symptoms of intoxication. They are caused by microorganisms of the paratyphoid group, the commonest being *Salmonella enteritidis*, *Salmonella typhi murium* (Breslau), and *Salmonella cholerae suis* (*suipestifer*).

Sometimes varieties of Bacillus coli and the para coli (Morgan's bacillus) and others are the causative agents. There have been cases of food toxinfections caused by Staphylococcus, Streptococcus, Proteus, Bacillus dysenteriae (Sonne-Kruse type).

The causative agents of toxinfections are not very pathogenic unless they enter the body in considerable numbers. Passing into the blood through the lymphatic system, microorganisms of the paratyphoid group produce a bacteremia of short duration. An endotoxin is liberated with destruction of the salmonellas in the blood or intestine (A. V. Roysler).

Until comparatively recently many physicians and microbiologists held that salmonellas elaborated a heat-resistant toxin in cooked and uncooked food. This view has now been totally abandoned. Experiments on monkeys and human volunteers have shown that properly heated food cannot cause toxinfections.

Statistics on food poisonings indicate that most of them are caused by meat and meat products, liver and cooked sausage, and canned fish in oil, in this order of frequency. Perishable items like low quality liver and cooked sausage are particularly dangerous. Poorly wrapped, they do not withstand boiling at 80°. The water temperature then drops to 50° and the food fails to become disinfected.

In recent years a number of cases of food poisoning caused by canned fish in oil (codfish and herring) have come to light in which the staphylococci survived even after 110° of heat due to poor heat conductivity of the oil. Such fish should be sterilized at a temperature of about 120° for 60 minutes. An important preventive measure is strict hygienic control of the oil tanks and pipes because the staphylococci can live and multiply in oil.

Toxinfections among soldiers are generally caused by foods of animal origin, chiefly meat and fish. Milk products and eggs are usually innocuous in this respect.

K. C. Petrovskiy's data on the causes of toxinfections (as %) during the four years of World War II are presented in Table 27.

TABLE 27

Cause of toxinfection	Years of the war			
	First	Second	Third	Fourth
Meat, meat products, meat dishes	45.5	43.5	46.6	57.8
Fish, fish products, fish dishes	27.2	17.4	18.0	21.1
Other products and unexplained cases	27.3	39.1	35.4	21.1

It is evident from the table that meat and meat dishes were the cause of approximately 50% of the cases of food toxinfection; fish and fish dishes accounted for about 20% of the poisonings.

Since the main cause of toxinfections is meat and meat products, many physicians have come to call the causative agents "meat poisoners."

The most favorable conditions for the growth of these agents are found in foods made from meat and fish stuffing, which are characterized by high moisture content, low concentration of hydrogen ions, and low salt content.

Intravital contamination of animals is to be distinguished from posthumous infection of meat or meat products. In either case lax sanitary inspection may lead to abundant seeding of the cooked food and infection of the consumers. A very common source of toxinfection is the meat obtained from the forced slaughter of animals. The meat of animals that were sick before slaughter is usually infected with salmonellas and requires extremely careful heat treatment.

Posthumous infection by salmonellas and other microorganisms occurs while foods are transported, stored, or processed. According to A. V. Reysler, this is due to direct contact of the meat and meat products with infected equipment, containers, hides and wool of sick animals. Man is occasionally a cause of toxinfection, although salmonella carriers are extremely rare. Rodents carrying S. typhi murium are another source of infection.

Under favorable temperature conditions microorganisms quickly multiply in cooked and uncooked foods. Cooked food is disinfected by proper heat treatment. However, if cooked food that is not boiled again or browned becomes contaminated, there is a serious danger of its causing a toxinfection. To prevent raw foodstuffs from coming into contact with cooked items, meat and fish must be cut up and stored in a different place from where cooked dishes are prepared and kept.

Toxinfections may be caused by milk and some milk products, ice cream and the mixtures used to prepare it, gelatin, jellied meat and fish dishes, meat pies, and liver sausage. These are all good nutrient media for salmonellas and other microflora that cause toxinfections. It is well to remember that infected foods do not differ in taste or appearance from healthy foods.

The simplest and most effective method of preventing toxinfections among the troops is proper heat treatment of meat and fish dishes and storing them in such a way that they do not come into contact with raw and semi-prepared foods. Cooked food must not be kept in a warm place. Breakfast and dinner must be so planned that cooked food doesn't remain in the kitchen more than two hours. If they have to be kept longer than that, they should be placed in a refrigerator. Before serving, soup should be brought to a boil and meat dishes carefully warmed up.

According to A. V. Reysler, microbes of the paratyphoid group in bouillon and milk are completely destroyed at 60° only after an hour. They die within five minutes at 70°. That is why soup brought to a boil is safe. Meat or fish is not usually heated so long. The short time it takes to brown meats and the low heat conductivity of meat and fish dishes explain why toxinfections are caused by stuffing, roasts, stews, etc.

Duck and goose eggs may be infected by bacteria of the salmonella group. These microorganisms have been found in the intestine, gall bladder, liver, and ovarian follicles of waterfowl. In case of decreased resistance the microorganisms may enter the hematopoietic system and infect the meat and eggs of the fowl. Restaurants are therefore forbidden to serve cream pastries made with duck and goose eggs, ice cream, and mayonnaise. Only hardboiled eggs may be used. The time for boiling is 8 minutes for duck eggs and 10 minutes for goose eggs (the time is reckoned from the start of boiling). Duck and goose eggs are used in baking bread and the like.

During World War II there were fewer cases of food poisoning at the front than before the war. Taking the number of outbreaks in 1940 as 100, there were 45 during the first year of the war. Subsequently, the number of toxinfections rose somewhat, but it never exceeded 60%. This marked drop in food poisonings of bacterial origin was due to the special arrangements made in connection with the distribution and preparation of food in the field. The soldiers received cooked food from field kitchens in which, with few exceptions, it was impossible to make fish and meat stuffings, roasts, and stews. Small bits of meat and fish were used to prepare liquid and semi-liquid dishes requiring prolonged cooking. Portions of meat no more than 10 cm thick and weighing less than 0.25 kg were placed in the kettles. Equally important, after they were cooked the meat and fish were not usually heated again (except when sliced). The food was not kept around very long; the preparation was so organized that it could be promptly passed out to the soldiers. When the combat situation made this impossible, the cooked food was kept in a cool place.

The sharp decrease in toxinfections at the front was also due in part to the extensive use of canned meats for soups and other dishes. During the four years of the war there wasn't a single case of food poisoning attributable to canned meat. Moreover, most of the meat products were delivered to the front frozen or chilled. Another major factor was the work of army doctors, army sanitary inspectors, and front sanitary inspectors who worked in close cooperation with the quartermaster corps.

An analysis of the data on food poisonings is essential if preventive measures are to be soundly organized in the rear. According to K. S. Petrovskiy, the causes of food toxinfections as derived from official reports are as follows:

1.	Lengthy and improper storage of cooked food	58%
2.	Food products of low quality	14%
3.	Insufficient heat treatment of food products	9%
4.	Undetermined causes	19%

Thus, the main cause of food poisonings of bacterial origin was improper (prolonged) storage of cooked food. These cases usually occurred in kitchens and mess halls that were overloaded (two or three shifts). An investigation of the outbreaks showed that cooked dishes were sometimes kept four to six hours before they were served. Toxinfections were generally caused by meat and fish dishes.

Throughout the war there wasn't a single case of food poisoning resulting from serving freshly prepared food. It was found that properly heated meat (2.5 to 3 hours of cooking) was an effective preventive of bacteria-caused poisoning.

Properly cooked food cannot cause poisoning unless there is secondary contamination from being kept in the kitchen a long time. Should this be necessary, soups and meats must be reheated before serving.

Staphylococcal Intoxications. Professor P. N. Lashchenkov discovered in 1899 that food poisoning may be caused by pyogenic staphylococci. Further research here and abroad showed that staphylococci produce an enterotoxin capable of causing the characteristic symptoms of intoxication. Weakness sets in within two or three hours. All the sufferers become dizzy, 50% have diarrhea, 30% vomit. Body temperature, as a rule, is not elevated.

Sources of poisoning are cheese, pastry, creamed pie, and tinned fish in oil (sprats, codfish).

In May 1945 there were three outbreaks of staphylococcal infection in an American army hospital in Oxford. The cause was a mixture of powdered milk, powdered egg, starch, and sugar intended for ice cream. About 600 men suffered during the second outbreak.

In 1946 there was a mass poisoning in the American army due to a pudding. Some 4,000 soldiers were affected (Boyer).

In studying enterotoxic staphylococcal strains A. I. Stolmakov discovered that an enterotoxin is formed in potato soup within five hours at a temperature of 19 or 20°. When the temperature was raised to 35 to 37°, the time it took to form the toxin fell to four hours. It took 18 days when the temperature was reduced to 5 or 6°.

Enterotoxin is formed in porridge at 19 or 20° within eight hours, at 35 or 37° within four hours, at 5 or 6° within eighteen days. The same is more or less true of milk.

The same data indicate that heating the filtrate containing the enterotoxin to 96 to 98° does not destroy it even after 1.5 hours. Food products infected with enterotoxic staphylococcal strains have caused staphylococcic intoxication in animals after an hour of heating at 96 to 98°. Two hours of heating at the same temperature apparently destroy the enterotoxin.

Stolmakov's research has shown that outbreaks of staphylococcal intoxications may have been caused by the insemination of cooked and uncooked food by persons working in kitchens and mess halls. The mucous membranes of the mouth and nose are a breeding place of staphylococcal enterotoxic strains. Pyodermas among workers in food enterprises increase the number of staphylococcus carriers and the frequency with which the microorganisms are found on the skin of hands. The need of strict medical examination of personnel working in kitchens and mess halls is obvious. Personal hygiene and sanitary inspection of food areas are important preventive measures.

World War II outbreaks of staphylococcal intoxications in hospitals for slightly wounded and convalescent soldiers were generally due to the convalescents' being drawn into working in the kitchen. In military units there were no food intoxications of staphylococcal etiology throughout the war.

Since the enterotoxin accumulates even at room temperature (18 to 20°), cooked and uncooked food must be stored at temperatures that prevent the staphylococcus from multiplying (2 to 4°).

Botulism. The prevalence of Cl. botulinium everywhere (in the soil, manure, excrement of animals, fruits and vegetables, fish) and the high toxigenicity of the microbe testify to the importance of botulism.

Five varieties of causative agent have now been distinguished: A, B, C, D, and E. Type A is more common in America, type B in Europe. Type A and type B bacilli play a fundamental role in human pathology. Type E is very rare, while types C and D are not isolated from man.

It is well know that C. botulinum forms spores that are highly resistant to heat (at 100° - six hours). The causative agent of botulism produces a toxin capable of surviving in food unchanged for a long time. The toxin forms during the growth of spores under anaerobic conditions usually in items where oxygen cannot enter (canned foods, sausages, cartilaginous fish). This does not happen, however, at temperatures below 20°.

The toxin of Cl. botulinum is the most potent of all known bacterial toxins in its poisonous effect on man and animals. As little as 0.0001 mg can kill a guinea pig. It cannot be destroyed in the gastrointestinal tract by the digestive juices and is exceptionally thermostable. In Van Ermengem's experiments the toxin of European strains of the bacillus was destroyed at 100° within a few minutes, at 80° within 30 minutes, and at 58° within 3 hours. Other data indicate that it is destroyed at 70 to 73° within 30 minutes.

Its effect is intensified in an acid medium (pH of 3 to 4); it loses almost 90% of its toxicity in an alkaline medium (pH of 7 to 8), according to K. I. Matveyev.

A high NaCl concentration (about 18%) does not destroy the toxin.

The usual source of poisoning is food favorable to the development of the bacillus, e.g., various kinds of cartilaginous fish (sturgeon). There have been cases of botulism arising from the consumption of herring, salmon, smoked bream (A. V. Reysler), and, more rarely, ham. Canned foods are safe due to rigid state control of the packing process. Abroad, judging by the literature, botulism is caused by canned meats and fish, sausage,fish, and cheese.

The botulinus toxin is a neurotropic poison. It is quickly absorbed after entering the stomach where it paralyzes motor activity. It causes paralysis or paresis of the eye, throat, and other muscles. Death follows bulbar paralysis, paresis of the vagus nerve, and involvement of the cardiac ganglia.

The symptoms of poisoning appear within 2 to 12 hours, sometimes 5 or 6 days later. The sufferers complain of pains in the stomach, constipation, and double vision. An examination reveals dilation of the pupils, sluggish reaction to light, strobism, blepharoptosis, paresis of accomodation, paresis of the pharyngeal muscles and soft palate. The patients experience thirst, but the attempt to slake it causes them to cough because liquids get into the nose and throat. The pulse is slow at first, but then speeds up; arterial pressure drops. Body temperature is low (below normal). Aspiration bronchopneumonia is common.

In his monograph Botulism Matveyev cites data revealing that everyone who eats food containing the botulinus toxin will come down with the disease. The main symptoms are weakening of vision, impairment of accomodation, diplopia, dryness of the mucous membranes of the nose and throat, hoarseness followed by aphonia, increased pulse rate, occasionally diarrhea and vomiting. Body temperature is normal or below.

The incubation period varies from 9 to 10 hours to 3 days or more. Death may occur any time from 24 hours to 10 days. Recovery takes 2 to 4 months. The mortality rate ranges from 16% (Germany) to 66% (United States). The latest outbreaks of botulism in the United States resulted in 82% mortality (Rosebury and others).

The clinical diagnosis may be confirmed by injecting white mice intraperitoneally with the citrated blood of the patient, water from a gastric lavage, or an emulsion of fecal material. Feeding the animals with some of the suspect food is a very important diagnostic aid.

The patient is given a gastric lavage with a 5% solution of soda and then injected intravenously with 20 ml of polyvalent serum. Olive oil is introduced into the stomach. Enemas are indicated. Adrenalin and strychnine are injected intramuscularly.

The most effective way of preventing botulism is to maintain rigid sanitary control over the food packing industry. Foods must be chilled during pickling. It is particularly important to chill before and after pickling those meat and fish products which are eaten raw. Any fish or meat with signs of a purulent deposit must, if intended to be eaten raw, be regarded as dangerous. Tinned foods are to be rejected if they appear to be swollen. Adequate heat is the only practicable way of destroying the toxin and disinfecting doubtful items.

In a future war the enemy may employ bacteriological weapons, particularly Cl. botulinum or its toxin to contaminate food being prepared or in storage. This would be the work of saboteurs. The possibilities are very limited, however, in food plants with mechanized production facilities.

The potential military use of botulinus toxin -- one of the most lethal of poisons -- is looked at differently in foreign literature.

The minimum lethal dose of the toxin for man when taken orally is still unknown. There are rough estimates derived from experimentation on animals. According to T. Rosebury and co-workers, the minimum lethal

dose for mice (injected subcutaneously) is $2 \cdot 10^{-7}$ g per kg of body weight. Accordingly, the minimum lethal dose for man has been determined to be $2 \cdot 10^{-5}$ g.

Meyer and Eddy describe a fatal case of poisoning by cheese containing the toxin. The patient ate 70 g of a piece of cheese weighing 200 g. After the remaining 130 g were titrated, it was found that each gram contained 50 lethal (mouse) doses of the toxin. Consequently, the 70 g consumed contained 70 x 50 = 3,500 lethal doses. The patient weighed 110 kg. This means that there were approximately 30 lethal (3,500:110   32) doses (for mice) per kg of weight.

Therefore, the lethal dose for a man of average weight (70 to 80 kg) is equivalent to 2,500 mouse doses.

Deck and Wood discovered that the lethal dose for monkeys, when the toxin was taken orally, was less than the equivalent established for mice injected intraperitoneally. Thus, the minimum lethal dose for man may be considered to be determined. A graphic idea of the potency of the toxin is given by Dixon, who has noted that serious injury or death may result from simply tasting - without swallowing -- contaminated food. The reason is that the toxin is very easily and rapidly absorbed in the mouth.

It is highly significant that the toxin is not affected by the digestive juices, which explains why it can act through the gastro-intestinal tract. It is fairly thermostable, some 10 minutes of heat at 73° or 6 minutes at 80° being required to destroy it. If the toxin is present in food of low heat conductivity, the heating time and temperature must be increased.

Botulinus toxin does not spoil when kept on ice and in a dark place. It can withstand room temperature for several months. It is very tolerant of low temperatures as well as of alternate freezing and thawing.

In the event of war it would be important not only to make a timely and correct diagnosis of poisoning by the toxin, but also to detect it in raw and cooked foods. Tests on white mice and guinea pigs are used for this purpose. Blumberger and Gross recommend injecting guinea pigs intraperitoneally with 2 to 5 ml of the serum of a patient to confirm the clinical diagnosis. If the toxin is present in the serum, the animals exhibit characteristic salivation; paralysis sets in within 24 to 48 hours.

Vaccination with antibotulinus toxin is a specific prophylactic measure. Treatment includes the use of a polyvalent or bivalent (A and B) serum.

American army bacteriologists concede that the causative agents of tularemia, brucellosis, and malignant anthrax could be used for military objectives. However, they all stress the unreliability of this group of agents for contaminating cooked and uncooked foods. In the opinion of T. Rosebury and his co-workers, infecting rats and insect vectors and, possible, the air is likely to be more effective.

The causative agents of intestinal infections might also be employed, but it is recognized that control measures are well developed. Nevertheless, we must keep in mind the possibility of the enemy's availing himself of these agents to complicate the task of feeding our troops.

Doctors should give serious consideration to J. Thayer's opinion regarding the possibility of causing diseases among animals scheduled for slaughter by infecting the fodder, manure, and gear. Wild animals could conceivably be used to infect domestic animals.

In the event of war we will have to expect a substantial increase in the number of gastric infections and make our preparations accordingly.

Owing to the threat of bacteriological weapons, areas occupied by the troops will have to be sanitized by destroying dangerous materials or rendering them harmless.

The possible use of rodents as carriers of the causative agents of many infectious diseases (plague, tularemia, etc.) makes it urgent to get rid of all refuse likely to attract these animals wherever troops are stationed or in combat zones (trenches, shelters).

Preventive Measures. The prevention of food poisoning is essentially a matter of eliminating the possibility of infection of both cooked and uncooked foods. This can be done only by an efficient system of medical supervision of the troops and, above all, by veterinary inspection of the slaughtering of cattle, cutting up of the carcasses, and transporting them to warehouses. Warehouses must be equipped with refrigerators to store perishable items.

Primary contamination of meat products can be successfully overcome by adequate amounts of heat.

It is particularly important in army kitchens and mess halls to implement measures aimed at preventing the development of pathogenic microflora in cooked food. The latter must not be stored at temperatures between 30 and 50°. Food left for the second or third shift must be kept in the cold at 4 to 6° or heated up to 80° or more. Food should not be kept about any longer than necessary.

Before food is served, it must be reheated (soup has to be brought to a boil).

The method of preparation must be carefully thought out. Raw and cooked meat (fish) are always stored separately. Meat and fish products are brought to the kitchen only in the quantity actually needed for a single meal. They may not be kept about for any length of time. A model plan for a kitchen-mess hall is shown in Figure 50.

Ultraviolet lamps have recently come into use in restaurants to sterilize work surfaces. According to Z. A. Ignatovich and Ye. I. Olen'yeva, the effect of sterilization varies with the material irradiated, type of microorganisms, and extent of seeding.

In irradiating galvanized iron complete sterilization is achieved within 10 to 20 seconds if they have been seeded with non-spore species and within 1 to 3 minutes if mold spores are present. Wooden work

surfaces require longer sterilization: 85% of the microorganisms die during the first 30 seconds; complete sterilization takes 15 minutes. An hour's exposure is required to sterilize wooden surfaces containing mold spores. If Escherichia coli and Staphylococcus are present, 95% of the microflora dies off within 30 seconds on a clean surface and only 75% on a dirty surface.

Sterilization of Dishes. The role of dishes in spreading intestinal infections, anginas, influenza, and other diseases has been experimentally established. The use of radioactive isotopes (radioactive phosphorus P^{32}) has led to the discovery of new facts making it possible to organize on a sound basis the process of cleaning, washing, and sterilizing dishes and to devise highly effective cleansing agents. This research has revealed that different kinds of dishes vary in the extent to which they may be freed from microorganisms. Earthen, glass, and stainless steel dishes are more easily and more completely sterilized by ordinary methods of washing than plastic or aluminum dishes. The hardest to remove is Staphylococcus aureus, the easiest Escherichia coli.

Many investigators state that the towels used for very dirty dishes serve to carry the microorganisms to clean dishes. After the plates and pans are wiped, the contamination spreads all over the tableware. The fact that dish towels contain a good deal of protein and fat makes them particularly dangerous because the microorganisms obtain a protein-fat defense.

In the Soviet Army pans, plates, and spoons are washed in three-section tubs installed in the washing area of the mess hall. It is recommended that a spray be used to scald the washed dishes. A special two-section tub is used to wash jars and teapots. In the first section the water temperature is below 45 to 50°; in the second section it is over 60°. Detergents are added to the first section to saponify the fat: 1 to 2% solution of soda ash, 0.5 to 1% caustic soda solution. Soap must be used on aluminum dishes because aluminum is darkened by an alkali.

It is well worth considering the tested idea of A. K. Koshcheyev of washing dishes in three-step tubs. These differ from ordinary tubs in that they are set at different levels. Holes are drilled in the sides through which the water pours from the first section into the second and from the second into the first (Figure 51).

By letting the dirtiest water from the first section go down the drain, these tubs make it possible to use the water in the second and third sections more efficiently. The hottest and cleanest water is available for the dishes in the third section. Detergents (soda ash, alkali) are added to the second section. These tubs, if there are boilers, permit the water in the third section to be changed after each batch of dishes is finished. The water temperature here is kept at 80 to 85°.

According to American investigators, heavy DDT treatment of potato fields has an effect for a number of years. Traces of DDT found in subcutaneous fat and breast milk are the consequence of eating vegetables dusted with DDT. American doctors attribute certain nervous diseases to DDT and similar preparations.

Organic phosphorus compounds are more toxic to man and animals, but they are quickly decomposed due to instability.

Poisonous Plants. Poisonous plants that may be accidentally used for food include water hemlock, dog's parsley, borovik [a variety of mushroom], belladonna, henbane, and others.

Water hemlock, the most dangerous of all, is widespread in the Soviet Union. It is found along river banks and in swampy areas. All parts of the plant are poisonous, particularly the rhizome, which is usually confused with the celery root.

Dog's parsley is found all over — in fields, orchards, and gardens. It is often taken for ordinary parsley from which it may be distinguished by an unpleasant odor.

Borovik is a low-growing bush found in the woods of Byelorussia and the Ukraine. It yields the so-called mezereum, which causes severe poisoning that is sometimes fatal.

Belladonna is indigenous to the southern regions of the country. The poisonous components are the alkaloids, hyoscyamine and atropine. The belladonna berry is called beshenaya [turbulent] because it acts as a stimulant on the system.

Henbane is a common weed containing atropine and hyoscyamine. Its seeds sometimes get into groats.

Poisonings by ergot, cockle, or darnel in the Soviet Union are now very rare due to the systematic application of agrotechnical measures in collective and state farms.

The severity of poisoning varies with the toxicity of the plant and individual predisposition to a given poison. The symptoms of poisoning include irritation of the mucous membrane of the gastro-intestinal tract, nausea, vomiting, diarrhea, and nervous excitation. At a later stage there are cramps, paralysis, collapse, and death due to paralysis of the centers of the medulla oblongata.

In administering first aid to sufferers it is extremely important to empty the stomach and intestine as soon as possible by lavage, emetics, laxatives, enemas, and diuretics.

The use of adsorptives and demulcents are recommended to retard or prevent absorption of the poison. The effect of the poison may be diminished by bloodletting followed by a transfusion, intravenous injection of glucose, etc. Education is an important preventive measure.

Feeding Troops in the Field

The Soviet Army uses various types and sizes of mobile kitchens to feed troops in the field. A two-boiler XP-2-48 field kitchen is shown in Figure 52.

The military situation determines whether field kitchens are used in inhabited localities or outside of them with due regard for camouflage requirements. They are set on clean, unpolluted ground near a source of water. A drain pit is dug at least 50 m away.

After the meal is prepared, the kitchen is carefully cleaned on the outside, the boilers washed with brush and hot water. The kitchen is then refilled with water and firewood. It is very important to keep the food box clean and neat and not use it for any other objects.

In the absence of a field kitchen the food is prepared in portable cast iron boilers and pails which are suspended from saw horses or set on metal supports or stonework. No food, particularly if it contains an acid, should be prepared in zinc or painted pails. Zinc may be dissolved by the acid and cause poisoning. A painted pail imparts an unpleasant taste to food. It is the responsibility of medical personnel to check systematically the condition of field kitchens and boilers.

Field kitchens with cooked food are brought to distributing points at the request of company commanders who send out guides to accompany the kitchens. Company commanders also determine the order in which the food is distributed. Food may not be served in dirty pots. It is essential to see to it that every soldier receives his allotted portion of meat or fish.

If it is impossible to serve hot food directly from the kitchens, the commanders send carriers to deliver it to their units in thermos bottles, pails, or cans. The capacity of the thermos bottles that come with field kitchens is 12 liters. Their insulating material makes it possible to keep food hot for three or four hours when the outside temperature is as low as -15°. In the winter pails and cans should be kept warm in light plywood boxes. The space between the sides of the box and pail is filled with paper, dry sawdust, or other insulation. If those bringing the food have to crawl, they pull the hermetically sealed thermos bottles and cans with a draw plate and, in the winter, on runners or skis.

Feeding Troops in the Far North

The working and living conditions of soldiers in the Far North differ in a number of respects from those prevailing elsewhere so that changes have to be made in the food rations and feeding system. This is due chiefly to climatic conditions in the Arctic (low mean annual temperature, strong, cold winds attaining a velocity of 40 m/sec, absence of night in the polar summer and prolonged polar night in the winter).

Some foreign experts suggest the following basic components of the arctic ration: 55% of the calorie content made up of fats, 34% of carbohydrates, and 11% of proteins.

Individuals permanently or temporarily stationed in the north must be given increased amounts of vitamin C and the B-complex vitamins.

According to the data of a group of Canadian physicians in charge of nutrition for a garrison stationed on the western shore of the Hudson Bay, the soldiers received an arctic ration consisting of 13% proteins, 41% fats, and 46% carbohydrates.

According to Rodale, who observed the feeding of fliers and infantrymen in Alaska between 1950 and 1952, an average daily calorie content of 3,000 for fliers and 3,200 for infantrymen completely satisfied the energy requirements. The average daily energy consumption per man for all four seasons did not exceed 2,800 cal. The author concluded that 3,000 to 3,500 calories are quite adequate for polar conditions. The proportion of protein, fat, and carbohydrate calories, in the opinion of the author, should not exceed that prevailing in garrisons (13% protein, 43% fat, and 44% carbohydrate calories). There is a higher consumption of fats in the winter. The need for minerals is also greater than in the temperate zone.

Soviet researchers have had many years of experience in observing the nutrition of members of polar expeditions. This has enabled them to work out scientifically the basic principles for the polar diet. According to O. P. Molchanova, the calorie content of the polar diet should be boosted by increasing the amount of fat, ascorbic acid, and the B-complex vitamins.

It is by no means desirable to add too much (to 55% of the calorie content, according to Gunell). It has been shown that too much fat causes nausea and lack of appetite. This was observed in 1946 during the farflung Canadian and American maneuvers in the arctic basin. The fat allowance established by the Institute of Nutrition, Academy of Medical Sciences amounting to 35% of the calories is apparently quite adequate.

The protein portion of the diet has been set at approximately 15% of the calories because there are no data available on the heightened level of nitrogen exchange under arctic conditions. The remaining 50% of the daily calorie requirement is met by carbohydrates.

It is extremely important to provide the essential vitamins. The lack of local fresh vegetables and fruits, the disproportion of canned foods and concentrates, the absence of insolation, and the working and living conditions of the men make it necessary for them to have somewhat more vitamin preparations. Vitamin D, in particular, must be given to adults as well as to children. Professor V. V. Yefremov suggests the following amounts: A - 5,000 I.U., B_1 - 2.5 mg, B_2 - 3.5 mg, C - 100 mg, D - 800 I.U., and PP - 25 mg. In addition, he recommends that all personnel be irradiated with ultraviolet rays during the polar night.

Water obtained from ice and snow is poor in minerals; the salt deficit has to be made up before it can be used. It is essential to add calcium salts and fluorine in order to bring the daily totals to 1 to 1.2 g and 0.5 mg, respectively.

Some of the local food products are poisonous — the liver of the polar bear (always), walrus and sea hare (sometimes).

One must not overlook the wild, vitamin-rich polar onion, cloudberries, and reindeer moss. In the Far North plants have the most ascorbic acid during the flowering period. The leaves of plants rich in vitamin C should be collected and dried for later use. For example, the leaves of red currants, which contain 1,500 mg% ascorbic acid, retain more than 600 mg% vitamin C after being dried at 50 to 60° (not in the light). Leaves of the dwarf birch contain 740 mg% and 400 mg%, respectively.

Feeding Troops in a Warm Climate

Warm weather requires that changes be made in the rations and daily feeding routine.

It is not easy to introduce new foods (chiefly of local origin) for economic reasons. The need of a new diet with special items is acutely felt only in the summer. At other times of the year climatic conditions do not call for any changes. Physiologically, it is not a good idea to introduce foods to which the men are largely unaccustomed. A shift to a different diet merely makes the task of acclimatization to the new environment more difficult.

It is quite otherwise with the arrangement of meals during June, July, and August. Local experience points to the need of switching dinner to the evening when the air has cooled off. This modification of the usual practice has hustified itself. The system is largely a matter of serving three meals a day.

Observations in Central Asia testify to the necessity of decreasing the amount of fat in the diet and increasing the carbohydrates, B-complex vitamins, and ascorbic acid.

Correct composition of minerals in the rations and strict observance of the drinking rules are highly important.

CHAPTER VIII

MARCH HYGIENE

A march is a movement of troops for the purpose of reaching a given place in combat readiness at a time stated by the commanding officer.

Russian military history is replete with examples of outstanding marches by major units over difficult terrain and under adverse weather conditions. The Suzdalskiy regiment under the command of A. V. Suvorov traveled 850 versts from Ladoga to Smolensk in 30 days. In the Italian campaign of 1799 Suvarov covered 50 versts with 27,000 men in a day, smashing the 36,000-man army commanded by Macdonald at Trebbia. Suvorov's famous 75-verst march across Saint Gotthard was accomplished in three days.

These examples show that Russian soldiers have brilliantly mastered the art of marching, which they were taught in peacetime. "Hard while drilling, easy while marching," said the great Suvorov, who was referring to the deliberate training employed to accustom soldiers to the hardships of war. Suvorov's marches are striking not only for their speed, but also for the vast distances covered. There is no doubt that 30 days of continuous travel covering distances of 850 versts require extensive training, endurance, and high morale. This explains why Suvorov's soldiers executed brilliant marches and at the same time met the enemy completely fit for combat.

During the civil war the Twenty-Sixth Rifle Division went through the mountainous regions of the Urals, covering 175 km in four days. During World War II Soviet troops traveled 30 km a day while fighting to liberate Byelorussia. In the battles for the Baltic in 1944 small and large Soviet Army units sometimes advanced at the rate of 50 km a day. During the Vistula-Oder operation our troops covered 30 to 45 km a day.

Nature of the Modern March

World War II revealed that soldiers sometimes had to march great distances despite motorization of the army. The Soviet Army is equipped with motor transport and so there is no more need of long marches. The men may be driven to a battle area, but before infantry units make contact with the enemy they have to move in march formation. During an offensive the troops move very rapidly even over rugged, roadless terrain and, in the winter, snow. An offensive in mountains, woods, or wooded swamps makes it impossible to use motor transport. Present-day marches differ from those in the past in several respects, particularly in speed of movement.

The load carried by soldiers is steadily increasing due to the development of military technology, notably automatic weapons (with more rounds of ammunition). In addition, they are burdened with tents, shovels,

gas masks, food rations, etc. The weight of all these things exceeds health standards (one-third body weight). It amounts to about one-half the weight, sometimes more. This load and the way it is packed have an effect on soldiers marching. Our body is functionally adapted to carry a pack on our back. It is much harder to do so if unevenly distributed and strapped in such a way as to constrict the chest and hinder circulation of the blood. Then too the objects may cover as much as 70% of the body surface and interfere with heat emission and evaporation of perspiration.

In addition to the weight and type of equipment, the rate of travel affects the way a soldier feels and his efficiency and endurance. The speed on dashes has recently risen to 8 km an hour. We know that, other things being equal, the amount of energy expended and rate of fatigue are determined by the speed of movement.

Energy Expended While Marching

A march with full field gear is equivalent to heavy physical labor. According to O. P. Molchanova, the amount of energy expended during a day of strenuous marching with field firing is in excess of 4,000 calories. Extensive research has shown that the average expenditure of energy expended in an ordinary day's march (25 to 30 km) does not exceed 3,700 to 3,800 calories. In forced marches it rises to 4,000 calories. Table 28 shows the amounts of energy expended in different types of marches (E. N. Klenov).

TABLE 28

Kind of action	Rate of walking, running, in m/min	Expenditure of energy in small cal in 1 min per kg of body weight
Rest lying down (without sleeping)		18.5
Comparative muscular rest while sitting		21
Slow walk	50	51
Parade step walk	80	146
Walking over sandy ground	80	107
Walking over cobblestones	94	125
Walking over snow 30 to 40 cm deep with a pack weighing 36 kg	50	181
Walking on skis with a pack weighing 26 kg	150	190
Walking over very rugged terrain	85.8	262
Double time march in service uniform	180	178
The same	320	333

The table shows that the amount of energy expended depends on three factors: speed of travel, weight carried, and kind of road.

The time of year and weather are also important. It is naturally more difficult to walk in the winter than in the summer; strong head winds offer considerable resistance. Walking in the winter is harder because of the warm clothing and boots as well as the slipperiness and unevenness of the road. Uniforms may become drenched by the rain and become 3 to 5 kg heavier. Wet uniforms, besides hindering heat emission from the body while one is walking, chill the body while one is resting. They can also irritate the skin.

The terrain and roads, as mentioned above, influence the amount of energy expended. A climb up a mountain raises the expenditure to 200 to 960 calories an hour (depending on the steepness) instead of the 140 to 200 calories used up while walking on level ground. A good road naturally requires less energy than a poor road.

A soldier who has had sufficient rest and sleep uses less energy while marching than a tired and sleepy soldier. That is why unbroken sleep at night and rest at halts is so important. The amount of energy expended while marching, especially double time, can be seen in Table 29, which shows how lung ventilation, i.e., the quantity of air inhaled, increases as a result of different kinds of movement.

TABLE 29

Kind of movement	Quantity of air inhaled in a minute, in liters
State of rest	5
Standing at the command of "Attention!"	6
Slow walk	10-12
March	15-18
Climbing a mountain	20-25
Double time	50 or more

Working muscles require more oxygen, which is supplied by erythrocytes in the tissues. Pulmonary ventilation is greatly increased when marching or running. The amount of air inhaled doubles even with easy walking; on the march it triples. It is 4 to 5 times the normal rate while one is climbing a mountain and 10 times or more while one is running. The consumption of oxygen and production of heat expressed in calories rise proportionately.

Conditioning is an important factor. A well trained, properly dressed and outfitted soldier uses less energy than an untrained soldier in ill-fitting uniform and shoes.

Marching is an exceedingly complicated motor act involving not only the sustentacular motor apparatus but also virtually all the organs and systems in our body responsive to conditioned reflexes. It is not

true that marching can be studied simply as a matter of energy expenditure, as foreign hygienists have done. It is equally erroneous to dismiss the significance of energy. An analysis of energy criteria is both useful and necessary in connection with setting dietary norms in order to compare the different kinds of marches -- in speed and distance to be covered -- and to appraise the effect of training.

However, it would be a radical error to draw conclusions as to the efficiency and endurance of Soviet soldiers only from energy criteria, which characterize the purely quantitative aspect of the work process, without taking into account its qualitative aspect and the significance of social factors.

Rate of Walking

The speed with which troops are able to march depends on their training, weight of the load carried, weather, time of year and day. The Drill Manual of the Armed Forces of the USSR specifies two types of steps: parade and route. The former is used in all drill exercises, ceremonial marches, salutes while moving, and when a soldier approaches his commanding officer. The latter is used at all other times. The rate is the same for both: 110 to 120 steps a minute, each 70 to 80 cm long. Multiply the rate (e.g., 120 a minute) by the average length of step (say 75 cm) to determine the speed of the march (5.4 km an hour). Allowing for a 10-minute rest period (brief halt), the average speed using a route step will then amount to 4.5 km an hour. If the pace is accelerated, the speed may rise to 135 steps a minute, the length of step increasing to 80 to 85 cm.

It has been found possible to increase the number of steps of the same length to only 150 a minute. Further increases cause a shortening of the steps and, consequently, a decrease in the rate of travel. The maximum occurs at a rate of 170 steps a minute.

It is well known from competitive walking that the absolute rate of travel in the sport depends on the distance covered, i.e., the greater the distance, the slower the speed (Table 30).

TABLE 30

Distance, in km	World record	
	Time	Speed, m/sec
3	11 min 59.5 sec	4.17
5	20 min 31.6 sec	4.06
10	42 min 31.0 sec	3.92
20	1 hr 32 min 28.1 sec	3.60
50	4 hr 34 min 03.0 sec	3.03
90	10 hr 04 min 20.8 sec	2.75

Physiologists and hygienists have carried out a number of investigations to determine scientifically the most efficient rate of travel for the human organism. This research has revealed that the rate of 90m/min suggested in the Drill Manual is the best. The slight decrease in expenditure of energy while walking at a lesser speed has no practical significance.

The rate of march mentioned in the Drill Manual changes of course in accordance with the combat situation. Experience gained in World War II showed that the rate and distance covered increased 1-1/2 to 2 times. Speed is raised chiefly by lengthening the step and increasing the number per minute. Greater speed is achieved by substituting the speed marching step for the route step. Approximately 11 minutes are required to cover 1 kilometer using the route step, whereas the same distance can be traveled in 9 minutes with the speed marching step and in 6 minutes and a few seconds by running. Well trained soldiers can cover 50 to 60 km a day, traveling 10 to 12 hours using the route and speed marching steps. The speed and distance can be further increased if the soldiers' packs are lightened somewhat.

The scientific reason for this, according to Fisher, is that an increase in load causes, other things being equal, a decrease in length of step and prolongation of the so-called period of double support. It has been experimentally demonstrated that following an increase in load the pace was shortened from 77 to 80 cm to 72 cm. It follows, therefore, a reduction in the load can by itself substantially result in increased speed.

It is necessary to use the route step when traveling over rugged terrain or wearing gas masks after a sharp ascent. The speed marching step is not used over deep snow, on sandy roads, in climbing mountains, or traveling over freshly plowed fields, swamps, etc.

Running with a weapon in one's hand and carrying full field gear is extremely exhausting and is done only over very good roads, down slopes, over flat meadows, etc.

The speed marching step must be alternated with the route step to prevent fatigue. Running is used to get by places covered by enemy fire. If a dash has to be made with full gear, the men do so by sprinting one or two minutes at a time. The rushes alternate with the route or speed marching step depending on the nature of the terrain.

The rate of 150 steps a minute with a length of at least one meter as specified in the Drill Manual permits a speed of 10.8 kilometers an hour. Just as in walking, the speed of running can be increased by lengthening the stride or accelerating the rate (i.e., increasing the number of steps per minute).

Dashes

In a combat situation marches may have to be completed with a dash at an average speed of about eight kilometers an hour. It is impossible to walk so quickly. Therefore, in a march-dash the speed step alternates with running (about 1.5 minutes of running to 6.5 minutes of walking). It has been found that it is best to cover 25% of the distance by running and the rest using the speed marching step.

Special attention must be paid to conserving energy on a march-dash. The reason, of course, is that it is sometimes necessary for the men to perform some combat assignment while on a march. Energy is conserved by the proper choice of method of travel with due regard for the tactical situation and terrain. Systematic training to accustom the body to strenuous physical labor is the only way of building great endurance.

The training program includes "mixed movement" (alternation of walking and running in the form of short dashes, starting with a distance of 1 to 1.5 km). Running, especially with full field gear, sharply increases the physiological load. It is therefore limited at the beginning of training to short distances (100 to 200 m) and interchanged with walking.

Planned training exercises in march-dashes are very important early in a summer encampment when the basic preparation of the soldiers for marching gets under way. The distance covered in practice march-dashes is as much as 5 to 7 kilometers. In many camps this may be much longer than the distance from where the troops are disposed to the training grounds and target range. If this is the case, a special route is devised.

Full field gear is carried only after the men are adequately conditioned (no earlier than the end of the second month of training). This gear is not carried on training march-dashes.

The medical service during the training period is responsible for observing the individual units (platoon, company), specifically, changes in body weight, pulse and respiration rates, vital capacity of the lungs, etc.

Breathing and Blood Circulation During Marches

Rapid walking during forced marches makes severe demands on the organs of respiration and blood circulation. From the medical point of view, this pace is like walking in a track meet and consumes as much as 180 liters of oxygen an hour. The cardiac output increases along with greatly intensified pulmonary ventilation.

The vast amount of energy generated during a march intensifies metabolism, which is accompanied by increased consumption of oxygen and formation of carbon dioxide. The need of more oxygen and elimination of the additional carbon dioxide results in expanded pulmonary ventilation.

Training for Marching

During training the body is gradually adapted to walking for long distances with full field gear. Preliminary systematic conditioning produces a number of distinctive physiological changes. These affect the lungs, heart, blood vessels, and central nervous system. There are also changes in the composition of the blood and urine and in the working muscles. Conditioning increases the functional potentialities of the organism.

A trained soldier functions more economically on a march, i.e., he uses less energy than an untrained man. He reaches the destination in good spirits and ready to fight. A soldier who ends a march complaining of fatigue has not been properly conditioned.

During training the distance covered by marches as well as the load carried are gradually increased. This strengthens and develops the muscles while improving the functioning of the cardiovascular system and lungs. The main responsibility of the doctor at this time is to prevent overtraining, which causes enlargement of the heart and dysfunction. Breathing control during training is also important. It is well to remember that ventilation of the lungs increases five- or six-fold when one is marching than when resting.

Training includes mastery of the technique of walking using the route step and functional conditioning of the body to render it capable of performing long and strenuous work requiring great endurance. Systematic training improves the interaction of internal organs (respiration, blood circulation, etc.) and motor apparatus. Conditioned reflexes are formed during training that facilitate adaptation to the variety of activities performed on a march. There is finer coordination of movements regulated by the central nervous system.

This does not mean, however, that the role of the sense organs is thereby diminished or eliminated. A. N. Krestovnikov's research has shown that peripheral vision plays a part in the formation of completely automatic motor skills. Furthermore, the ability to perceive kinetic, visual, and sound sensations develops in the process of forming and perfecting motor skills.

The gait of a trained soldier is economical in that all the movements are purposeful and virtually automatic.

The well known Russian physiologist N. Ye. Vvedenskiy in discussing the scientific principles of successful training stressed the importance of gradualness in increasing the load and systematic repetition of the exercises. Steady increases in the load help to adjust the central nervous system, lungs, and cardiovascular system to marching with full field equipment.

An important factor in successful training is the use of so-called maximum loads, i.e., speed marches with full equipment for great distances, forced marches involving the surmounting of a variety of obstacles, etc. These efforts increase the load on the cardiovascular system, lungs, and muscles and thereby raise the soldier's efficiency and limits of his endurance.

Gradual complication of the conditions (wearing of gas masks, night marches, winter field exercises, etc.), lengthening the distance covered, and adding to the weight of the pack all contribute to the formation of adaptive reactions by the body.

Effect of Training on the Body

Systematic training affects primarily the skeletal muscles. The processes taking place in muscular tissue due to contraction and relaxation produce changes in the composition of the blood and activity of the cardiovascular system, lungs, etc.

Table 31 (Krog and Lindgard) shows that the coefficient of oxygen assimilation by muscles in trained persons is much higher than in untrained persons.

TABLE 31

Subjects	Work, kg/m.	Consumption of O_2, cm^3	Minute volume of blood, liters	Coefficient of oxygen assimilation
Trained	458	1350	9.8	0.73
Untrained	446	1320	16.0	0.43

The muscles of a trained man use a large amount of oxygen per volumetric unit of blood. The coefficient of oxygen assimilation is raised by changes in the chemical composition of muscular tissue and by intensification of the enzymatic oxidation-reduction processes due to training.

During training there is decreased consumption of oxygen per meter of ground traveled or per kilogrammeter of work. Systematic training on skis results in an approximate 40% decrease in oxygen consumption.

Untrained persons very frequently exhibit a rapid pulse beat largely due to contraction of the diastole, which inevitably leads to poor filling of the heart with blood from the veins and shortening of the period of relaxation.

The effect of training on changes in the minute and systolic volumes of blood and on the pulse rate (at rest) are shown in Table 32 (Lindgrad).

TABLE 32

	Heart activity		
	minute volume of blood, in liters	systolic volume of blood, in cm^3	pulse rate per minute
Before training	4,774	62	77
After long training	5,665	103	55

During the intensified muscular work performed while marching the systolic volume of blood rises to 130 cm^3, i.e., 2-1/2 times, with a simultaneous increase in the minute volume of blood to 16 or 17 liters. During an ordinary march at a speed of 4.2 km/hr the minute volume is 13 liters; with an increase in speed to 5 km/hr the minute volume rises to 16.3 liters. Whereas the consumption of oxygen in a state of rest is 300 cm^3/min, during a forced march it increases to 1,600 or 1,700 cm^3/min, i.e., almost sixfold (Yu. P. Frolov).

An important indicator of the condition of the body after a march is the length of the recovery period, i.e., the time it takes to liquidate the "oxygen debt." In trained persons the amount of lactic acid in the blood during and after movement is less than in untrained persons. There is a proportionate decrease in the "oxygen debt" and the time it takes to liquidate it.

Untrained persons have a double accelerated (or faster) pulse beat (from 60 or 70 to 100 or 120 beats per minute) with virtually unchanged systolic volume. After forced marches of 30 km concluded with a dash, up to 150 beats a minute have been recorded. This pulse rate is normally accompanied by sharply pronounced symptoms of general fatigue. A dicrotic pulse is usually associated with lowered arterial pressure.

The time it takes for the pulse to return to normal is a significant factor in the condition of soldiers on a march. It should return to normal in a well trained man after 10 to 30 minutes of rest. A substantial acceleration of the rate (over 140 beats a minute) and prolonged period of recovery (more than 30 minutes) are regarded as symptoms of distinct overexertion.

Vital capacity of the lungs and depth of inhalation are important indicators of the condition of the respiratory apparatus. The vital capacity of the lungs following physical exercise, particularly a march, increases significantly depending on the intensity of the muscular work. In soldiers of medium build the vital capacity ranges from 3,500 to 3,700 cm^3; in marchers specially trained for competition it may reach 4,100 to 4,300 cm^3.

At the end of a march the vital capacity is usually decreased. Ten or twelve minutes after arriving at the destination pulmonary ventilation is 300 to 1,500 cm^3 less than at the start of the march.

The load carried may cause a decrease of 10 to 14% in vital capacity of the lungs; it may fall to 700 cm^3 in certain individuals. Shperk's data (Table 33) show the relationship between load carried and vital capacity of the lungs during a march.

TABLE 33

Load, in kg	Vital capacity of the lungs, in cm^3	Amount decreased as compared with a state of rest, in cm^3
20	3137	299
27	3051	379
31	3001	435

The decrease in vital capacity is explained by the fact that inhalations become shallower as the load increases. The straps of the gear press on the shoulders and constrict the chest. By the end of the march, moreover, fatigue also plays a part by preventing full utilization of the muscles involved in breathing. Consequently, the exertions of soldiers on marches can be lightened by having part of their equipment transported. It is equally important that the pack be correctly distributed on their backs. The equipment must be arranged in such a way as not to obstruct normal breathing.

Fatigue While Marching

Fatigue is the sum total of complex changes in the body arising from prolonged or intensive work. These changes are shown by impairment of a variety of functions and result in decreased efficiency. Consequently, fatigue should not be considered a local symptom affecting only this or that part of the body. Fatigue is caused by functional changes in the central nervous system.

It would be incorrect to say that the complex biochemical processes taking place in the working muscles have no effect on the development of fatigue. These processes do indeed play a part. However, fatigue is primarily a nervous process and that is why it shows up in functional changes in the nervous system. It produces changes in the organs of sight and hearing and in impaired coordination of motor acts. A tired soldier walks unsteadily and makes unnecessary movements. These are the external signs of central nervous system fatigue.

The rhythm of walking is markedly disturbed after a long march. Veteran officers are familiar with the "stumbling" gait of tired soldiers, which testifies to the disturbed coordination of muscular movements resulting from fatigue. The automatic quality of movements developed after lengthy training is upset. The main role here is played by the central nervous system.

Muscular work always causes a greater or less amount of fatigue, which is most pronounced on marches, especially forced marches over long distances. The extent of fatigue is largely determined by the weight of the load carried, rate of movement, nature of the road, time of year, weather, etc.

Temperature usually rises during muscular work. This is due to an excess of heat production over heat emission and to various bodily distrubances, including fatigue.

The most obvious signs of fatigue during a march is uneven, shallow breathing, rapid pulse beat which is sometimes irregular, occasional breathlessness, flushed or pallid face, profuse perspiration, unsteady gait, sluggishness, apathy to surroundings. The degree of fatigue may be judged from poor results of shooting or grenade throwing. If the military situation warrants it, the commander slackens the pace, lengthens the time of short rests, provides additional rest periods, and orders part of the load to be carried by truck.

Systematic training is the best way of coping with fatigue and, consequently, lowered efficiency. Soldiers in good condition do not experience great fatigue on a march, despite its difficulty.

World War II abounds in examples of how high morale enabled the soldiers and officers of the Soviet Army to overcome all obstacles. The passionate love of the motherland and hatred of the enemy, full awareness of duty, and unbounded devotion to the Communist Party enabled the soldiers to fight while marching sometimes as much as 15 km a day without feeling unduly fatigued.

Morale as a factor in preventing fatigue plays no small part in peacetime too. The soldiers' awareness of their responsibility for strengthening the defensive ability of our country and the unlimited devotion to the motherland, party, and government help to strengthen their military and political preparation.

I. P. Pavlov's teaching on the importance of the central nervous system in the development of fatigue completely explains why the signs of fatigue are overcome by the emotions (feelings and experiences reflecting the relationship of man to his environment).

The well known Russian physiologist A. A. Ukhtomskiy wrote in his <u>Physiology of the Motor Apparatus</u>: "Music or songs on marches, interest in one's work and the people near by (a generally sthenic reaction to the environment) may substantially diminish fatigability and even suddenly overcome the fatigue which has already begun to manifest itself in the form of sensations of tiredness. An asthenic reaction, "low spirits," may, on the other hand, suddenly reveal hitherto unnoticed fatigue and lead to genuine collapse."

Hence, high morale on the part of the soldiers, alertness, devotion to their socialist motherland, feelings of Soviet patriotism and will to win are important prerequisites for building endurance on marches. They create the emotional fervor that enables men to cover great distances without excessive fatigue.

Conservation of Energy

In order to prevent and combat fatigue, the regulations for marches (prescribed rhythm of walking, short and long rest periods, night and day halts) must be strictly observed.

Short rest periods are more than stops on the way; they are an important means of conserving strength and preventing fatigue. A soldier must know how to take advantage of these 10-minute stops. He must take off his pack and loosen his belt and gear straps. This helps to restore normal blood circulation and breathing, relieve the pressure on his skin and internal organs of the chest and abdomen, facilitate the emission of excess heat, and restore normal heat exchange. He should rest lying down, raising his legs to permit the blood to flow down. However, he can also rest half-reclining or even sitting in a comfortable position.

During a short rest period it is necessary to inspect the equipment carefully, to tighten or loosen the straps, and to fix the gear so that it doesn't interfere with walking. It is very important to reverse the ends of the puttees if they are frayed, particularly if the feet are sweaty. Bandages should be applied to raw spots.

During a long halt the soldiers must first take off the field gear, wash or wipe the feet with wet rags, reverse the ends of the puttees, clean their clothing, and wash their head, face, neck, and hands. It is very desirable to change or rinse the puttees, if only in cold water, and to dry them. During the summer it is a good idea to go barefoot, which is more restful and helps to toughen the skin. During the winter it is essential for the soldiers to rest in a warm place where they can change their shoes, reverse the ends of the puttees or replace them with fresh ones, remove the inner soles of the boots and dry them in the air. A rest of 1-1/2 to 2 hours is recommended after dinner before moving on.

A night halt is intended to enable the men to recuperate from the day's exertions. The site must be carefully chosen. Men who have slept well in a warm place will be able to continue the march with fresh vigor. The fatigue of the day is erased by a good night's sleep.

After arriving at the site of a night halt, the men take off their boots, wash their feet, and put on clean, dry puttees or reverse the ends. The inner soles are taken out and dried. If the weather does not permit them to walk barefoot, temporary inner soles are made of straw or hay.

It is not a good idea to drink much water right after arriving at the place of a night halt. Only a little should be taken to quench acute thirst. However, unlimited amounts of tea, boiled or disinfected water can be drunk after eating.

Marching in the Winter

Much more energy is expended on a march during the winter than during the summer. The reason is that clothing greatly hampers movements. Furthermore, the brief rest periods are greatly shortened when it is very cold, and there are no long rest periods if warm places cannot be found.

Walking on skis is unusual in several respects. Skiing is much quicker than walking if there are ski tracks. It requires approximately one and one-half times more energy than walking because it utilizes more muscles. The hands as well as the legs are involved. In skiing without sticks a great deal of work is done by muscles in the lumbar region of the spine, stomach, and shoulders.

It has been determined experimentally that the volume of pulmonary ventilation in a trained skier is 45 to 65 liters a minute; the pulse rate on rapid ski marches is over 150 beats a minute. Arterial pressure after a few minutes of rapid movement usually drops. The small drop in pressure among trained skiers is due to enlargement of the capillaries of the working muscles. A rise in arterial pressure to 160 mm mercury column indicates the need of decreasing the speed or calling for a halt.

The heavy physical load of skiers causes a substantial loss in body weight due to sweating that may amount to 3.5 kg over a distance of 30 km. It is believed that soldiers lose 0.5 kg of weight for every hour of skiing. The loss is much less in trained men than in novices.

The conditioning process is the same as for ordinary marching — gradual increases in distance and load carried. It usually begins with 5 to 7 km and steadily grows to 20 to 25 km. From time to time ski marches of 30 to 40 km are ordered to increase endurance. The same principle applies to the rate of speed.

Energy is conserved by rhythmic movements with no jerkiness or change in tempo. Soviet investigators have found that work performed rhythmically is more productive and less fatiguing. The rhythm set during the first portion of a trip (up to a brief halt) should be kept until the destination is reached.

On ski marches brief halts are called in accordance with the condition of the road, weather, and degree of training received by the men. The site is chosen so as to permit resting in a place sheltered from the wind. The time is shortened. There are no major halts in the winter due to the shortness of the day.

Skiing causes the production of a good deal of heat. Correct clothing must be worn for unimpeded emission of this heat. Leather and fur garments that tend to hold in heat are unsuitable for skiing. A sports jacket and trousers are perhaps the best for skiers. Felt boots are good on dry, frosty days. Cloth or felt jack boots are best when the weather is changeable. High overshoes are also suitable, but they must not be laced too tightly so as not to hinder blood circulation. Insoles are absolutely essential. It is important that the fastening of the skis not press against the feet and constrict movement.

Experience gained during major ski marches of the Soviet Army has shown that abrasions can be prevented by: (1) rubbing the body and legs with cold water upon completing a day's march and the next morning before continuing; (2) washing the legs, neck, and armpits with soap and water at least twice daily; (3) preventive bandaging of the feet and ankles.

It is important during a winter march to check whether the skin of the face, ears, nose, fingers, hands, and feet remains sensitive. The latter are particularly prone to frostbite, and are less likely to be noticed than other parts of the body. It is also important to bear in mind that feet may become frostbitten even when it isn't very cold. This happens most frequently perhaps during a thaw when the comparatively warm temperature of the day gives way to frost at night. The main cause here is wet shoes and damp puttees. That is why it is so important to change damp puttees and insoles and to dry out the footwear, particularly felt boots.

If frostbite develops, as may be determined from skin pallor and loss of sensitivity, the affected parts must be rubbed vigorously but not roughly with the hand, towel, or clean handkerchief. There should be no rubbing with snow, mittens, or coat sleeve to avoid injuring and infecting the skin. The skin is rubbed until it reddens and regains sensitivity. First aid is administered in a warm room or place sheltered from the wind. A dry bandage is applied (no rubbing) if there are blisters (second degree frostbite).

Wet shoes and clothes are the main cause of frostbite among skiers. Therefore, the clothes and shoes must be dried out at every possible opportunity, socks or puttees changed, insoles dried or changed.

If the cold is accompanied by strong winds, the earflaps of the cap must be lowered and triangular cloth aprons tied around the hips to prevent the sex organs from becoming chilled.

In strong winds the skiers at the head of the column are most exposed and they should periodically change places with the others.

Marching in Mountains

Marching in mountains requires traveling over narrow paths and stony debris, snow, and glaciers under the conditions of low atmospheric pressure and sharp changes in temperature in the course of a day (the daily drop in temperature is often over 50°). With altitude the air temperature drops, absolute humidity decreases, and solar radiation intensifies.

A source of danger in mountainous regions is ultraviolet radiation, which may cause conjunctivitis or snow blindness.

The drop in atmospheric pressure in mountains causes a reduction of the partial pressure of oxygen both in the atmospheric air and in the alveoli of the lungs. The effect on the organism is intensified by the pack, ammunition, food, tent, and sometimes the fuel carried by the soldiers.

The force of the wind may be 20 m/sec or more. The low temperature after sundown makes it difficult to set up a night halt, especially in the winter when snowstorms impede movement.

It is difficult to walk with a normal rhythmic pace. The need of controlling each step makes for fatigue.

In preparing for action in the mountains it is very important to condition the cardiovascular system and lungs. There is no need of selecting special people for mountain combat. During World War II ordinary infantry, artillery, engineer troops and others, as well as regular mountain troops, successfully fought and smashed the enemy in the Caucasus and Carpathians. However, this fact does not exclude, indeed it underlines the need of special training for mountain fighting.

The distance to be covered and the speed are determined by the nature of the route (condition of the roads or paths, nature of the ground, snow or ice, steepness of ascents and descents, height above sea level). In difficult sections of the road the pace generally becomes uneven; walking is unrhythmic, agitated, and tiring. At great heights (4.5 km) the pace may drop to 30 steps every 30 seconds with 30 seconds for rest; the step is shortened to 50 cm.

According to A. N. Krestovnik, at 2,000 m and a grade of 5 to 10° the best tempo is 100 steps a minute at about 3 kilometers an hour (including 15 minutes of rest). With a slope of 15 to 20° he recommends a pace of 60 to 70 m/min at 2 kilometers an hour; with a slope of 25 to 30° the speed drops to 1 kilometer an hour at a pace of 40 to 50 m/min.

The author stresses the importance of avoiding sprints and maintaining an even pace. There should be 5-minute stops at comparatively short intervals of time (from 15 to 50 minutes depending on the altitude and grade). Breathing should be slow, even, and deep.

Owing to the difficulties of walking all movement should be halted as soon as the command is given; otherwise the rest period will be consumed by the laggards catching up, with only those at the head of the column getting any rest. During the rest period the soldiers should breathe deeply and evenly. They are taught early in training that frequent, shallow breathing during rest periods is ineffectual. Deep breathing enables a greater amount of air to reach the alveoli and thereby increase oxygen tension in alveolar air. It also eases the work of the heart and helps it to fill with blood during the diastole.

Theoretical considerations as well as practical experience indicate that in marches at high altitudes brief rest periods are not in themselves sufficient for regaining strength. There must also be 30-second to 1-1/2-minute stops depending on the condition of the men as determined from the way they are breathing by the commanding officer or doctor. Since the main purpose of these stops is to help breathing and blood circulation, it is impossible to fix them by the time spent in covering a given distance or by the steepness of the slope. The only sound criterion is the condition of the men — breathing and blood circulation.

The distance to be traveled each day cannot be predetermined because of such secondary factors as the ascents and descents, condition of the roads and trails, and low barometric pressure. According to V. K. Solov'yev, a day's march for trained units in an average mountainous zone might be set at 20 km with an ascent to a pass of up to 1,000 m. At altitudes above 3,000 m the distance should be shortened to 10 to 15 km. In forcing a pass at an elevation of about 4,000 m, 9 to 10 km are considered the limit.

Mountain Sickness

The difficulties associated with marching at high altitudes are complicated by mountain sickness. The initial symptoms may show up at a height of 2.5 km, although it is more common at 4 to 5 km. The chief cause of mountain sickness is a drop in the partial pressure of oxygen due to decreasing atmospheric pressure with height.

The symptoms differ from individual to individual. At first there is shortness of breath and weakness; then fatigue quickly sets in, frequently preventing further climbing and demanding rest. Dizziness, nausea, vomiting, and sudden loss of consciousness with leg and abdominal cramps are common. Impaired motor coordination and trembling of the hands, which is particularly noticeable when attempting to write something, also occur. The effect of oxygen deficiency shows up in unwarranted elation that later turns into heightened irritability and sleepiness. The appearance of these symptoms calls for complete rest and, in severe cases, the administration of oxygen. These measures bring relief fairly promptly.

The symptoms of mountain sickness due to impaired autonomic functions frequently precede changes in higher nervous activity and in the sense organs. According to A. N. Krestovnikov, these changes show up in (1) intensification of the processes of stimulation and weakening of the processes of inhibition; (2) decreased acuity of vision, narrowing of the field of vision, enfeeblement of accommodation, impaired color perception (green and blue), decreased light sensitivity; (3) slightly impaired hearing; (4) sharply diminished olfaction to total loss of the ability to detect odors; (5) changes in taste (urge for sour and sweet, aversion to meat); (6) decreased tactile sensitivity; (7) increased sensitivity to pain. All these changes result from a drop in the partial pressure of oxygen in mountain air, which causes hypoxemia, i.e., insufficient oxygen in the blood. Hypoxemia results in disturbance of the oxidative processes in the tissue and intensified pulmonary ventilation leading to hypocapnia, i.e., subnormal concentration of carbon dioxide in the blood.

The best way of combatting mountain sickness is to halt the march and allow the officers and men to rest. If circumstances do not permit this, the soldiers' packs must be lightened. Oxygen or carbogen (a mixture consisting of 94% oxygen and 6% carbon dioxide) may be administered in acute cases.

Mountain sickness can be prevented by strict observance of the rules for movement and rest, changing when the conditions encountered warrant (steepness and height of slope, weather, etc.). Systematic training with gradual conditioning to mountain marches is the best preventive.

The experience of people who have lived for a long time in mountains indicates that man can adapt to rarefied mountain air and will not experience mountain sickness even at altitudes of 4 to 5 km. It is a familiar fact that when the inhabitants of plains live in mountains for a long time they feel better, cease to breathe heavily, and no longer complain of dizziness and headaches. This process of daptation of plains people to mountain climate and low atmospheric pressure is called acclimatization. The period of adjustment to altitude ordinarily does not take more than two months. Acclimatization is most rapid during the first two or three weeks when the adaptive reactions of the organism are being developed.

Acclimatization may be accelerated by active training, which includes physical exercise, e.g., morning gymnastics, practice in climbing rocks, walking on snow and ice, and hikes in the mountains. These exercises tone up all the organs and systems and prepare the body for new activity.

The mechanism of acclimatization to high altitudes is explainable by I. P. Pavlov's physiological theories. The new living and working conditions cause functional changes of adaptive character that heighten resistance to oxygen insufficiency. The body responds with functional changes in the respiratory, cardiovascular, and blood-forming systems to the decrease in partial pressure of oxygen in mountain air. The changes resulting from a comparatively long stay at high altitudes (at least 12 to 14 days) persist for 1-1/2 or 2 months even after returning to level country. The amount of erythrocytes and hemoglobin is then restored to the original level. Tolerance of low oxygen pressure and intensified oxidative ability are retained for a fairly long time.

Marching in mountains makes unusually great demands on a soldier due to the character of the terrain, sharp fluctuations in temperature, intensity of solar radiation, low partial pressure of oxygen, dryness of the air, strong winds, absence of protection against the elements, lack of fuel, etc. Thus, adequate medical measures are exceptionally important. These include:

(1) careful planning of a climb with due regard for the steepness of the slopes and degree of training of the men;

(2) gradual hardening of units unaccustomed to mountain conditions, especially at altitudes of 3,000 m or more;

(3) reduction of rest periods to a minimum due to the danger of body chilling;

(4) mandatory wearing of overcoats during long halts.

(5) shifting the time of dinner to the evening because the severe physical stress of mountain climbing hinders normal digestion;

(6) concern for protective measures against the intense solar radiation (smoked glasses, thick paper shields with cross-shaped slits or hair nets, face salve).

The great dryness of the air at high altitudes causes fairly substantial losses of water, which can be made up through food and drink. Intensified metabolism makes a sound diet unusually important. The possibility of hypoglycemia developing, especially in untrained soldiers, is something that must be kept in mind. The daily ration should contain adequate amounts of carbohydrates and the correct proportion of fat.

Night Marches

Marches in a modern war are often executed at night generally with considerable air support. Marches at night or under conditions of limited visibility (fog, rain, snow) were common during World War II. Such marches are more fatiguing than day marches because it is difficult to see the road. On a dark night the rate of travel over a poor road is about one-third the normal, i.e., 3 km/hr. On a moonlit night over a good road the rate may be as much as 4 km/hr. A successful march requires preliminary reconnaissance of the route and possible stopping places. Long halts are ordinarily not scheduled in order to save time and prevent the men from falling asleep.

A major responsibility of the medical service is to examine carefully soldiers suffering from defects of vision. For example, those afflicted with hemeralopia should not be assigned to reconnaissance groups or patrols or march security. These soldiers are to be kept under the supervision of NCO's or medical instructors. If possible, their pack should be somewhat lightened.

Conditioning for marches is very important. The initial marches may cause considerable nervous and mental tension, but this is more or less completely overcome in time as a result of training. The men gradually develop the required skill and come to the destination in a cheerful frame of mind.

Just before a march the men should have at least seven hours of uninterrupted sleep. The daily detail sees to it that there is no talking or other noise. The soldiers sleep in dark rooms and 1-1/2 hours before starting receive hot food. Canteens are filled with tea just before setting out.

Preparations are suited to the time of the year and weather. Marches are so planned that all the units arrived at the destination by dawn.

The following are the responsibilities of the medical service on a march:

(1) inspection of the route and proposed brief stopping places;

(2) detecting those suffering from visual defects and arranging for them to be kept under the supervision of medical instructors or noncommissioned officers;

(3) finding those weakened or tired out by previous marches so as to have them relieved of part of their packs;

(4) participating in the preparation of march training charts with provision for dark adaptation.

It should be borne in mind that adaptation to new conditions of light takes 10 minutes, whereas dark adaptation requires 45 to 60 minutes. The speed with which dark adaptation may be acquired depends on how much vitamin A is present in the organism, particularly in the retina, and the ability of the central nervous system to receive minimum light stimulation. Therefore, men detailed to reconnaissance or march security should stay in as dark a room as possible for an hour before the march begins.

Men before engaging in marches or battles at night should have adequate amounts of vitamin A in their food (at least 5,000 I.U. or 3 mg of carotene). It has recently been learned that vitamin C too has a favorable effect on dark adaptation. Caffeine is suggested as a stimulant of night vision.

Desert Marches

Deserts generally have few roads, severe climatic conditions, lack of inhabited points, and little water. The medical service is responsible for the following in connection with a march in the desert: (1) preparation of a chart of movement and rest with a designation of the halts at sources of water; (2) organization of sanitary reconnaissance of the route (for poisonous snakes and insects, disease-bearing rodents and insects); (3) careful analysis and evaluation of the sources of water; (4) execution of measures to improve the quality of the water.

In working out the movement chart the senior physician of the unit must take steps to prevent sunstroke in the summer and frostbite in the winter. The hottest part of the day is reserved for rest to avoid overheating.

The insufficiency of water in deserts makes it urgent that the rules for water use be strictly observed.

The water, as a rule, is highly mineralized. The taste can be improved by adding citric acid, fruit juice, strong tea, or coffee.

Water is issued only after it has first been disinfected with chemicals or boiling. Water from irrigation ditches often contains pathogenic microbes along with the cysts of protozoans. In addition to being chlorinated, this water is first coagulated and then filtered.

Wearing Gas Masks While Marching

The threat of a chemical attack on marching soldiers makes it essential that gas masks and anti-chemical preparations be kept in readiness. Wearing a gas mask makes breathing and heart action more difficult on a march. Moreover, the face part of a mask interferes with vision and hearing.

Gas masks cannot be worn comfortably without systematic training. Conscientious training helps to diminish or even eliminate the adverse effects on breathing, blood circulation, hearing, and vision.

It has been learned from many years of experience that sitting quietly wearing a mask serves no purpose, for it does not prepare the soldiers for the various conditions that they may encounter in combat or chemical warfare.

Correct breathing technique is vital and is acquired by all kinds of exercises. Training begins with the men familiarizing themselves with the mask and developing the correct rhythm of breathing while wearing it. This is followed by a walk of 20 to 30 minutes, the length being increased to 40 or 50 minutes the third time, to an hour or more the fourth time (the route step alternating with the speed marching step). The fifth exercise is a 100 or 200 m sprint. The time is gradually increased to 2 or 2-1/2 hours involving various kinds of movement.

Training continues long after the men have learned how to march wearing masks so as to strengthen their newly acquired skill using the route, rapid marching, and double time steps. This requires drill exercises, field exercises, marches, rushes, and march-dashes. Experience has shown that a high level of training can be maintained indefinitely if the mask is worn at least 2-1/2 or 3 hours once a week.

There is a good deal of moisture in the face part of the mask in warm weather due to increased sweating. The skin eventually becomes irritated. Hence, the training time is shifted to the cooler morning or evening hours.

The mask is not taken off as soon as strenuous muscular work is completed because the heart and lungs are adjusted to the changed conditions occasioned by wearing it. The mask must be worn for some time after exercise.

A march-dash is scheduled only when the men are accustomed to this kind of activity without wearing masks and after they have learned ordinary marching with them. The same holds true of ski training — first a mastery of ski technique without masks, then ordinary marching wearing masks, steady increases in speed, distance, and difficulties, and finally ski marching wearing masks.

There is no reason to fear frostbite under the facepiece (helmet) where the temperature is usually higher than the air temperature and the opening is covered by the earflaps of the cap. However, frostbite of the face is a possibility when the temperature is around 30°.

It has been fully proven that soldiers can walk about in gas masks for 2 or 3 hours or wear them indefinitely sitting or lying down. It is quite possible to learn to sleep in a mask after only a little practice. Soldiers get accustomed to it after 2 or 3 nights and there is no danger to health. Should the tube of a mask become crimped (by being squeezed or bent) and make it very difficult to breathe, the soldier will quickly wake up.

Drinking on Marches

Thirst is generally caused by insufficient water in the body. However, it may result from drying of the mucous membranes of the mouth and throat, which frequently happens on marches, in athletic contests, during singing, and after prolonged talking (lecture, report). The mucous membranes may become dry in certain emotional states (agitation, fear, etc.). This type of thirst is quickly relieved by simply moistening the membranes.

Intense thirst along with substantial losses of water by the body occurs during swift marches, while moving earth in connection with the building of field type of defensive installations, and in athletic contests (football, long-distance running, etc.). The thirst is caused by extensive loss of water due to copious perspiration. Intense thirst is accompanied by pronounced dryness of the mucous membranes of the mouth and throat, ultimately becoming exceedingly painful.

The actual need of water and the subjective sensation of thirst sometimes do not coincide. One must therefore take into account the condition of the body and correctly evaluate the causes of the sensation of thirst. If it is due to dryness of the mucous membranes or emotional state, 2 or 3 drops of water will suffice to quench it.

On a march, particularly in warm weather, a soldier will lose a good deal of weight as a result of heavy perspiration. The amount depends on a number of factors: temperature, humidity, intensity of heat radiation, physical load, etc. Air temperature and physical load are the most important. A substantial amount of chlorides (about 0.5%) is lost with the sweat. This means that 25 g of chlorides are lost with 5 liters of water. In Central Asia the loss of water may be as much as 9 or 10 liters so there is a threat of chloride impoverishment. However, in view of the comparatively large supply of chlorides in the body (140 g, according to Magnus-Levy, or 100 g, according to Hack) and constant replenishment with food, the danger of chloride deficiency is almost negligible. G. Ye. Vladimirov found that the daily army ration includes approximately 30 g of salt; in addition, 7 to 9 g is supplied by bread.

At one time a number of investigators suggested a water-salt regimen to eliminate the danger of blood clotting, help decrease thirst, lower body temperature, and improve the sense of well-being of soldiers on a march. These favorable results — to be achieved by consuming 10 to 15 g of salt before a march — were attributed to adjustment of the salt balance in the organism. It was thought that the heavy loss of salt with copious perspiration could be compensated for by increasing the consumption of salt with food.

Due to the substantial loss of sodium chloride with perspiration the law calls for workers in hot shops to be supplied with salted (1% solution of sodium chloride) and carbonated water. Some armies have adopted a different "salt ration" for temperate and hot climates (French

soldiers are given 17 g of salt in Europe and 30 g in French Soudan). The American army in World War II added one pound (453.6 g) of salt per 100 gallons (378.5 liters) of water.

A careful study of the problem by G. Ye. Vladimirov and his co-workers showed that there is no basis for adding salt to food before a march. The research, which was conducted during a Central Asian summer, revealed no signs of subnormal quantities of salt in the body with a weight loss of 3 to 4 kg. The salt content of the blood remained unchanged and there was practically no excretion of salt with urine. Parallel observations with salt supplements failed to show any persistent increase in chlorides. Nor did the addition of salt prevent clotting.

The same findings were reported about ten years before by V. K. Solov'yev who discovered that adding salt to the diet of soldiers on a march during a Central Asian summer produced no useful effect; actually, it turned out to be very disagreeable. The fact is a person with sufficient salt in his body doesn't really need any more when marching. The loss of salt following heavy sweating is easily made up by these reserves.

Soviet Army rules for drinking on a march are essentially as follows: (1) do not use water from sources found along the way; (2) drink water only from your own canteen or from springs and wells authorized by the commanding officer; (3) do not drink at will just because of a sensation of thirst, for it may be deceptive. Unnecessary water overloads the body with fluid, causes copious perspiration, and lowers efficiency and endurance. The purpose of the army rules is to ensure that the soldiers obtain what they need for their health, efficiency, and endurance on a march. The rules are particularly important in a hot climate when increased sweating may cause thirst by the time of the first brief stopping period. Even in a temperate climate on a hot summer day the desire for water is strong.

In hot weather a soldier needs about 5 or 6 liters of water a day, 2.5 to 3.5 liters for drinking (including tea), the rest in the preparation of food. On a march in hot weather and with strenuous physical work a soldier must eat at least 25 g of salt daily with his food. This amount is supplied with his ration which contains about 30 g of table salt. Consequently, there is no need of any salt supplement.

The rules urge no drinking at the first and second brief halts. For dryness one or two mouthfuls held as long as possible in the mouth should suffice. At the third and fourth halts after 5 or 6 minutes of rest one or two glasses of water may be drunk. This should be done as slowly as possible. Ten or fifteen minutes after arriving at a major stopping place one or two glasses may be drunk after the mouth is rinsed. Before setting out again after a major halt or night halt, water or tea may be drunk until the thirst is completely quenched.

The flasks are filled with boiled or disinfected water by orders of the platoon or company commander. If possible, tea is used instead of water. Cold tea does a better job of quenching thirst and contributes

to the sense of well-being and efficiency of the men while it decreases fatigue and makes for cheerfulness. The inhabitants of Central Asia are well aware that hot tea is effective in quenching thirst, and they do not use water for this purpose. Tea not only relieves the sensation of thirst, but it also has a favorable effect on the cardiovascular system and secretion of gastric juice. The sugar added to tea replenishes the carbohydrates used up in muscular work.

One should not drink directly upon arrival at a night halt. After the mouth and throat are rinsed, no more than one or two glasses of water should be drunk, a little at a time. Unlimited quantities of tea or disinfected water can be drunk after supper or dinner.

Heat Prostration

There is marked intensification of heat production on a march due to muscular work. It has been shown that difficulties in heat emission may be caused by high air temperature and heavy or ill-fitting clothing. Therefore, overheating of the body is possible when the temperature climbs to 38° or higher. This overheating results in prostration.

Heat prostration is observed among troops chiefly in the summer, on marches, when the conditions are ripe for increased heat production along with difficulties in heat emission. These conditions are more common in the southern than in the temperate latitudes. For example, in 1873, during a march across the Karakum desert 107 out of a detachment of 2,165 men suffered from heat prostration.

One of the indicators of the condition of a soldier is body temperature. A temperature of 38.0 to 38.5 or more indicates impaired thermoregulation and possible overheating. Thus, the range between optimum and dangerous temperatures for efficiency on a march is only 1.5°. This indicates the high degree of sensitivity of the body's thermoregulatory mechanism. Perspiration is an important factor in thermoregulation. An ordinary pullover tunic saturated with sweat retains over 0.5 liters of moisture. Evaporation of this moisture requires an estimated expenditure of 270 calories as a result of which the body begins to cool.

Overheating on a march is caused by high air temperature and humidity, stillness of the air, intense solar radiation, fatigue from previous work, inadequate training, wearing of clothing not suited to the weather, high speed, and great weight of field gear.

Heat prostration shows up in a variety of forms beginning with weakness and ending with collapse. Early symptoms include congestion in the head, headache, nausea, heaviness in the legs, flickering in the eyes, yawning, dizziness, and locomotive disorders. The sufferers have elevated body temperature, rapid pulse, and increased respiratory rate. If first aid is administered in time, the symptoms quickly disappear.

Heat prostration may set in suddenly in the form of collapse. Severe symptoms occasionally appear four to six hours after a march is ended while the men are resting. There are disturbances of the central nervous system, the consciousness in particular being affected with symptoms ranging from sleepiness to deep coma. Some men have convulsions of epileptic nature or become delirious. Paralysis or speech disorders are comparatively rare. Body temperature is generally elevated (sometimes to 42°). Rapid pulse, respiratory difficulties (tachycardia or bradycardia), and anuresis are very frequent. Sometimes there is vomiting and diarrhea.

The principal sign of recovery is the return of consciousness. An initial improvement is sometimes deceptive so that the patient's breathing and blood circulation must be very carefully observed. Heat prostration is to be regarded as a serious disease requiring hospitalization.

The condition can be prevented by the following measures:

(1) Start the march as early in the morning as possible so that the destination or major halt can be reached before the hottest part of the day;

(2) Do not proceed in close order, for this hinders air circulation among the men and makes heat emission difficult;

(3) Try hard to select shady, airy places for halts;

(4) Provide the men with a continuous supply of good drinking water;

(5) Observe the rules for drinking water;

(6) Schedule meal times when all or a good part of the trip has been covered (at least 1-1/2 to 2 hours should elapse between eating and resuming the march);

(7) Do not allow the men to go without hats on hot, sunny days;

(8) Allow the men to march with unbottoned collar and rolled-up sleeves;

(9) Relieve the men of part of the load (overcoat, haversack, engineering equipment) insofar as this is possible;

(10) Shift periodically the soldiers in the middle of a column because they are in the least favorable position for heat emission;

(11) Have the NCO's and medical instructors watch the inadequately trained soldiers and those with little endurance;

(12) Alert the officers and NCO's to the possibility of heat prostration.

At the first signs of impaired thermoregulation (sluggish walk, irregular breathing, heavy sweating, unsteady movements, reddening or pallor of the face) the soldier should be promptly withdrawn from the ranks and placed in the shade where he is relieved of his pack, has his collar loosened, and belt, tunic, and undershirt removed. He is given water and ice bags or wet towels are aplied to his head and neck. Counterindications for the latter are impending collapse and increased irritability.

Artificial respiration is used in case of collapse and oxygen administered. Bloodletting, injection of physiological solution, and heart stimulants (camphor, caffeine, strophanthus, and cardiazol) are indicated. Intravenous injection of a physiological solution of sodium chloride and glucose is effective and quick acting. Sufferers from sun stroke should be sent to a hospital in a car since traveling on foot is dangerous.

Heat prostration can be prevented by wearing properly fitting, loose, and airy clothing, which facilitates the emission of heat. It is particularly important that the clothing be able to absorb perspiration. It is a well known fact that the men sweat profusely on a march during hot weather. The sweat cools the body as it evaporates. If the underwear and outer clothing do not absorb the sweat and help it to evaporate, overheating is inevitable.

Clothing, as noted above, must also be airy. Otherwise the men have difficulty in emitting heat and run the risk of becoming overheated during strenuous muscular activity. It is difficult for air to pass through new, unlaundered cloth. The so-called size is washed out in the laundering process and the cloth becomes porous. Hence, laundered underwear and outer clothing provide better ventilation while marching than do new garments. They are also preferable in connection with the evaporation of perspiration.

The shape and fit of clothing are even more important to health. A soldier has to walk quite a bit. That is why his underwear and outer clothing should be loose and not constrict blood circulation or hamper breathing. While he is being outfitted, he should check to see that his clothes are not too tight, that they allow him to move about freely and do not prevent him from running, jumping, or crawling. He should bear in mind that clothes shrink all over when they are laundered.

In the summer tight clothing clings to the body after it becomes wet with perspiration and displaces the air spaces between the body, underwear, and tunic. The result is impaired heat circulation between the body and the outside air and the likelihood that the skin will become rubbed.

Sanitary-Hygienic Arrangements in Connection with the Transporting of Troops by Truck

Troops are often transported by truck to increase the speed of movement and conserve their energy. However, riding trucks is very tiring if continued for a long time over poor roads and the vehicles are improperly equipped.

A column of trucks can make much better time and cover greater distances than men on foot. Brief halts are made every two or three hours to inspect the vehicles and enable the men to get some rest (at more frequent intervals in freezing weather). As a rule there are no

major halts. It is important that the regulations for keeping prescribed distances between the trucks be observed in order to prevent poisoning by exhaust gases.

Riding in a truck, unlike walking, involves static muscular tension rather than dynamic work. By static tension we mean the tension of muscles without movement; dynamic work differs from static tension in that it entails movement.

Static tension is known to cause fatigue more rapidly than dynamic work does. Unbroken static exertion is usually possible only for a few minutes. The central nervous system plays a major role in the development of symptoms of fatigue due to the static exertion connected with riding in a truck. In static exertion there is a continuous flow of nerve impulses from the tendons and muscles to the central nervous system and back. Fatigue results from prolonged excitation. In dynamic work, on the other hand, the flow of impulses takes place only when the muscles contract. Consequently, when the muscles are relaxed, the flow of impulses between the central nervous system and muscles ceases. The intervening break enables the muscles to rest.

While the trucks are moving, there is comparatively little muscular tension. If the vehicles are not equipped to carry persons and the men have to stand or sit on the floor with tensed muscles, fatigue may set in. This happens on long trips, so seats should be provided to conserve their energy. The blood stagnates in the veins of the lower extremities when the men have to stand still for a long time. There is also limited movement of the chest, i.e., a decrease in the volume of air inhaled and exhaled.

During short halts the men should get out of the truck and limber up by running or walking rapidly to overcome congestion in the veins. Two or three minutes of exercise are helpful: (1) deep breathing in and out; (2) raising the arms overhead while simultaneously kicking first one leg backward, then the other, followed by lowering the arms and relaxing the muscles of the upper extremities and trunk; (3) bending the trunk forward as far as possible while simultaneously raising the arms, etc.

The brief halts should be used for active rest to get rid of static tension and not for pointless lying down or sitting on the ground.

Soldiers transported in open trucks are more exposed to the weather than when marching on foot. In winter the motion of the vehicle intensifies the cooling effect of the air. This increases heat emission but not heat production owing to the lack of muscular work. Low air temperatures and strong winds are conducive to overcooling and colds. In hot weather a breeze helps heat emission and increases the sense of well-being.

Trucks moving over dirt roads raise a good deal of dust which settles on the hats, clothes, and equipment. It penetrates into the mouth and nose, irritates the respiratory passages, and inflames the mucous membranes of the eyes. As a protection against foul weather, particularly in the fall and winter, trucks are equipped with awnings to protect the men from the rain, snow, and wind. If the vehicles do not have awnings, the men may use ponchos for this purpose.

It is extremely important that the legs be kept warm in the winter. Straw or pine branches are spread on the floor of the trucks to prevent chilling of the legs and frostbite. Insoles of felt, quilted cloth, straw, or hay are inserted into the boots. Newspaper or wrapping paper (two or three layers between the summer and winter puttees). In the winter the men sit with back to the wind (with backs to the driver while the machine is moving). The trucks are stopped from time to time to enable the soldiers to get out and run around to warm up. The legs, puttees, and shoes must be kept dry if frostbite is to be prevented. Wet socks and puttees are replaced with dry ones before getting into the trucks -- not only in the winter, but also in the fall and early spring. If the puttees can't be replaced, the ends should be interchanged.

As a column proceeds, the lead vehicles emit great amounts of exhaust gases containing carbon monoxide, which causes poisoning if inhaled for any length of time. This danger is lessened if the cars move rapidly and keep the prescribed distance from one another. Slow travel with shorter distances in between, especially through narrow, wooded clearings, is dangerous. The greatest danger of poisoning by exhaust fumes comes from a group of trucks standing in a gully or woods with motors running. The ignition should be turned off during brief halts. If for some reason this can't be done, the men should get out of the vehicles and rest on the windward side. Calisthenics should be performed away from machines with running motors.

There is no difficulty in observing the rules for drinking water because the loss of water by sweating while riding in a truck is slight. Experience has shown that a single canteen of water per man is quite sufficient until arrival at the site of a night halt or major rest period. Water should be drunk only during halts. It is inadvisable to drink water at the first two brief halts. The dryness in the mouth that creates a sensation of thirst can be overcome by one or two mouthfuls of water.

Static muscular tension and vibration of the truck as it moves over poor roads create digestive difficulties. Therefore, one should not eat too heavily or overload the stomach with water or tea before getting into a truck. Lunch or dinner should be eaten 1 or 1-1/2 hours before departure.

As soon as the destination is reached, the equipment, clothes, and shoes are cleaned, followed by changing or removal of the shoes, weather permitting. If the weather is too cold to go about barefoot, the feet are wiped or rubbed with a clean, damp rag. Clean, dry puttees are then put on or the ends interchanged.

If a major halt is scheduled in the summer at a place where there is a stream or pond, bathing is a good idea, for it is an effective way of combatting fatigue and restoring energy.

Medical responsibilities in connection with the transporting of men by truck include: (1) inspection of the route and resting places; (2) prevention of chills and frostbite; (3) observing the condition of the men en route.

Sanitary-Hygienic Arrangements in Connection with the Transporting of Troops by Railroad

When troops are moved by railroad, especially in wartime, the correct organization of sanitary-hygienic protection of the echelon en route is highly important. This is provided by authorized medical personnel if a unit or its subdivisions are transported in separate trains. If supernumerary groups temporarily formed at the loading point go along, the medical staff to accompany the echelon is designated by the health agencies of the Ministry of Transport. Medical care is furnished before the echelon is dispatched and en route.

A major task of the medical service is to prevent the outbreak of infectious diseases. The danger is acute in transporting troops for long distances since they have to remain in the cars for many days. Crowding, impossibility of showering or changing the underwear, inevitability of contact with the population en route, difficulty of controlling the procurement of foodstuffs locally -- all these are factors favorable to the development of infectious diseases. Hence, protective measures are essential.

Before entraining the men are examined to detect any who are ill, especially those with infectious diseases. The latter are isolated and those who have been in contact with them are kept under observation, their temperature being taken twice a day.

The documents on vaccinations are carefully checked while the men are being examined. All non-immunized officers and men are given the prescribed vaccinations. If the full set can't be given because the time or place doesn't permit, the additional injections are given on the way. The medical officer accompanying the echelon obtains the necessary vaccine and instruments (syringe, heating device) at the place where the group is formed.

Just before entraining the men must be medically processed in a garrison bathhouse or at a railroad isolation-control post.

The medical personnel accompanying the echelon are required to inspect the cars, which must be carefully washed and fumigated. Each car is supposed to be equipped with plank beds and a stove (in the winter), pail, and lantern. The railroad administration is responsible for cleaning, disinfecting, and equipping the cars.

Special cars are set aside for an isolation area, field kitchens, and food storage.

En route the medical personnel make daily inspections (morning and evening) of the cars and periodic spot checks of the soldiers for lice. If any are found or if the trip takes more than seven days, the men are medically processed and the cars fumigated. If there is any evidence of epidemic typhus, the entire echelon is given treatment promptly.

The medical personnel are also responsible for care of the sick and sending to civilian or military hospitals those officers and men who need additional treatment.

Upon arrival at the destination the soldiers are examined and those suspected of having an infectious disease isolated.

CHAPTER IX

PERSONAL HYGIENE

Personal hygiene is the set of rules of behavior designed to protect the health and increase the efficiency and endurance of soldiers. Their personal and collective life is virtually inseparable both in peacetime and in wartime. Thus, strict compliance with the hygiene requirements specified in the Interior Service Regulations is far from being a matter of concern to the individual soldier alone. The entire unit is directly involved for it affects the military readiness of all. Violation of the regulations may result in insufficient training in peacetime and decreased combat efficiency in wartime. Frostbite, blisters, and purulent skin infections are generally caused by the failure to obey the rules of personal hygiene.

Strict compliance with these rules is particularly important for all soldiers involved in any way in the feeding and supplying of troops with water. Any violation by a baker or cook or food warehouse attendant may have serious consequences for the whole unit.

Personal hygiene is as essential in wartime as in peacetime. However, in wartime the problem is complicated by the lack of lavatories, driers for puttees, foot baths, etc. However, in World War II field baths, showers, and mobile laundries were provided. When the front was fairly stable, various units built baths and laundries with their own resources.

Prevention of Frostbite

The history of war knows many examples of frostbite occurring among troops stationed not only in the northern latitudes but also in the temperate zone. During the winter of 1709 Charles XII lost a good many soldiers in the Ukraine as a result of it. While Napoleon's army was retreating from Moscow in 1812 a vast number of men died of the cold. During the Crimean War (1853-1856) 5,215 French soldiers suffered from frostbite and 1,178 died out of an army of 309,000 men. There were 2,398 cases in the English army. During the Russo-Turkish War (1877-1878) 7,057 men were affected.

N. I. Pirogov called attention to the unexpectedly early appearance of frostbite among the Russian troops near Shipka and Plevna (September 1877). The principal cause, the great surgeon believed, was the weakened condition of the soldiers and serious defects in their boots. "At the end of September," he wrote, "we saw hundreds of frostbitten feet. In answer to our query, the sufferers almost unanimously blamed their boots, which they kept on their feet too long."

According to official records, there were 1,469 cases of frostbite in the Russian army and 5,086 in the Japanese army during the war of 1904-1905.

During World War I some 37,700 cases were noted in the Italian army, more than 100,000 cases in the French army. According to the Prussian Ministry of War, out of 500,600 sick and wounded soldiers in 1914-1915 some 12,848 were frostbitten.

Thus, cold weather has a serious effect on the health and combat efficiency of soldiers. It is an enemy to those inadequately prepared to cope with it, but not to those who are hardened and trained for winter operations. It can be rather easily prevented by employing measures available to every soldier. This requires a knowledge of the causes and factors promoting its development.

The factors predisposing to frostbite are: (1) low air temperature combined with strong winds; (2) sharp break in the weather and an alternation of a frost with a thaw; (3) wearing of clothes and shoes that are improperly fitted and not appropriate to the weather; (4) enforced immobility, particularly long stays in damp trenches; (5) interference with local blood circulation due to mechanical constriction of the blood vessels (tight lacing of shoes, putting on puttees incorrectly, etc.); (6) loss of blood because of wounds; (7) insufficient nourishment and lack of hot food; (8) excessive fatigue and inadequate conditioning to cold.

During the four winter campaigns of World War II frostbite posed a threat to the field army due to the mobile nature of the war and vigorous activity of the Soviet forces. The barbarous destruction of inhabited localities by the retreating German fascist invaders made it impossible to use the houses either for quartering of the troops or for hospitals. During the period of bitter battles our troops had to spend days, sometimes weeks, in the open exposed to frost, winds, and snow. In the northern sectors of the vast front stretching for 3,000 km the soldiers battled during long, fierce winters with an acute shortage, sometimes a total lack, of heated quarters. Moreover, the highly developed military technology that required the men to maintain continuous contact with metal while servicing combat and transport vehicles, airplanes, artillery pieces, and mortars contributed to the development of so-called "contact frostbite."

Frostbite during World War II did not occur only in the winter. More than 29% of the total number of cases were recorded in the northern sectors of the front in the spring and 31.5% in the fall. The greatest number of cases were observed during the winter campaign of 1941-1942. The incidence decreased steadily thereafter.

The lower extremities which are always in contact with the cold and damp ground, wet snow, etc., as was to be expected, were most frequently affected. Tight shoes and lacing, which impede normal circulation in the legs, predispose to frostbite. Wet socks and puttees, poor care of the feet and shoes, and the impossibility of drying the feet and shoes in cold, damp weather are other factors.

Infantry and artillery units suffered most from frostbite.

An analysis of the causes of frostbite show that most of them are attributable to prolonged subzero temperatures, which affect the peripheral parts of the body — finger tips and toes, ears, nose, and supraorbital ridge. The condition develops quickly and sometimes unexpectedly. The bones are rarely affected (chiefly the ungual phalanges); the process usually develops in soft tissues.

Following frequent contact with cold metal "contact frostbite" may suddenly develop on hands unprotected by gloves. The imprint of the metal object appears on the hands. Contact frostbite is very common among armored troops, airmen, transport workers, etc., i.e., where the men have to touch cold metal.

Trench foot is a typical form of wartime frostbite. It occurs mainly after a prolonged stay in damp trenches where the men move about very little -- in the spring, fall, or winter.

Chilblain usually occurs when low air temperatures are combined with dampness. It is confined chiefly to exposed parts of the body. The characteristic erythema and infiltrate frequently become ulcerative. Chilblain is fairly common among troops in the field during cold and rainy weather.

Frostbite due solely to low air temperatures is relatively rare. It is usually associated with factors that intensify the effect of the cold, e.g., wind, humidity, sudden changes in the weather, thawing and freezing. The layer of air next to the skin is warmed by the heat produced by the body and forms its own air membrane which serves as a protection against the cold. Creation of this membrane is helped by multilayered porous clothing that prevents the warm air from being crowded out by cold air. The convection currents observed even when the air is still do not cause sharp cooling. When there is a wind or during swift movement (as in an open truck) the warm layers of air next to the skin are continuously crowded out by cold air. The body, so to speak, is under a cold air shower, the effect lasting for hours, sometimes days. The wind, which accelerates heat emission from the entire body surface, directly affects the exposed areas (face, neck, nose, ears).

Wetting the clothes results in increased heat conduction of the garment and decreased heat production. Wet shoes and socks are particularly dangerous. Trench foot is caused chiefly by wet shoes. The mud in trenches is infinitely more dangerous than frozen, snow-covered soil. Snow melting at a comparatively high temperature is much worse than dry snow during a bitter frost.

A sudden change in the weather accompanied by a sharp drop in temperature, unexpected frost, melting snow and rain cool the body abruptly and frequently cause frostbite. Spring and fall frosts that set in at night after a thaw commonly result in frostbite.

Besides external factors, the condition of the men, degree of hardening to cold, and training for winter operations also affect the development of frostbite. Hardened men accustomed to the cold and to

life in the field withstand low temperatures very well. Untrained men, on the other hand, frequently suffer from chilblain and frostbite in the winter. Resistance is lowered by general exhaustion following [illegible] from an illness, fatigue caused by prolonged and strenuous work, malnutrition, or drinking too much alcohol. A considerable loss of blood is very conducive to frostbite. The wounded, therefore, must not be left on the battlefield in the winter; they must be promptly removed and warmed with blankets, chemical heaters, etc.

Good food in adequate quantities is important in preventing frostbite. Eating hot food and tea increases resistance to cold. S. Maksomov and Ya. Smelkov demonstrated experimentally that the temperature in the extremities rises 6° or more after eating. The temperature does not rise immediately; it starts to rise 30 to 60 minutes after eating, reaching a maximum 3 or 4 hours later. This should be kept in mind in organizing the feeding of troops in the winter.

Before World War II fairly extensive use was made of fat and grease to protect the exposed parts of the body and lower extremities. Experiments and the experience of the first year of the war showed, however, that so far from preventing frostbite they actually helped to bring it on. By dirtying the puttees and skin of the feet they made skin metabolism more difficult through blocking the pores and kept the skin moist. For this reason, from the fall of 1942 on, the troops were forbidden to use any fat or grease as a preventive of frostbite.

The first step in preventing frostbite is to outfit the men with correctly fitting clothes, particularly shoes. It is exceptionally important that their resistance to cold be increased by planned hardening measures and by accustoming them to withstand temperature changes. These measures are best combined with physical exercises.

Shoes must be comfortable and always oiled. In bitter frosts inner soles of cloth, felt, or straw should be inserted and then dried out or changed at the first opportunity. If a long march is not scheduled, the feet may be encased in summer puttees of soft (newspaper) paper with winter or other summer puttees on top. This simple and convenient means of keeping the feet warm in the field is recommended for snipers, units on duty in trenches, and for troops transported by railroad or truck, etc. Each soldier should carry with him on a march an extra pair of clean puttees to replace at the first opportunity the wet ones he may be wearing.

The best way to care for sweaty feet is to wash them in cold water at night and at halts during a march. If there is little or no water at all, the spaces between the toes should be wiped with a damp rag.

During a ski march it is important to see to it that the straps do not press too hard against the feet or constrict them when moving. If head or cross winds are blowing, the soldiers at the head and on the sides of the column should be relieved frequently.

Skin sensitivity of certain parts of the body (face, ears, nose, fingers, feet, hands) is checked from time to time on a winter march. Any insensitive pale area is rubbed until it becomes red and sensitive again. NCO's are responsible for observing their men and administering first aid at the first signs of frostbite (marked pallor of the face, ears, or nose).

Those required to stay motionless in the cold for some time (snipers in firing position, units on duty in trenches, the wounded and sick) are urged to use chemical heaters.

During the transporting of troops by truck: (a) the men should protect themselves from the cold by sitting with their backs to the wind or in the direction the car is moving; hay or straw is placed on the floor; (b) the men should frequently move their arms and legs to increase blood circulation; (c) in unequipped vehicles protection from strong winds is provided by tent sections; (d) during halts the men should get out of the trucks and run about for a while.

The nature of a sniper's duties in the winter requires that special attention be paid to his clothing and footwear. The clothing should be waterproof, roomy enough so as not to interfere with his movements or impede blood circulation, and afford protection against the wind. Paper pads may be placed on the stomach and back to provide warmth during severe weather. A sniper should have comfortable boots with leather soles and felt or cloth insoles, woolen puttees and socks. His hands should be protected by fur mittens with three fingers on the right hand. Before leaving for his post the sniper should be given hot food or tea (no vodka). In cold and damp weather it is desirable for him to be supplied with two chemical heaters, which remain effective longer if wrapped in a towel or paper. According to S. Maksomov and Yu. Smolkov, the application of chemicals to the abdomen quickly warms the extremities by 1 to 6°. Maintained for two hours or more, this warming delays chilling, especially of the lower extremities. Use of a chemical heater on one arm or leg warms the other one too, sometimes much more.

Snipers in firing position, artillery observers, and all others who must not expose themselves by moving should in cold weather wriggle their toes and fingers, bend their legs at the knees, arms at the elbows, etc. Army doctors have observed that even slight movement of one of the extremities tends to warm the others that are immobile.

Motorcyclists are protected from the cold by underpants or cloth triangles, quilted jackets, and coveralls. Paper pads on the chest and back are very helpful. Heavy cloth masks are useful in severe frosts accompanied by wind.

First aid for frostbite includes: (a) artificial respiration (if necessary) in a warm room; (b) active warming of the frozen extremities in a water bath, with the temperature increased to 37° in 20 to 30 minutes; (c) washing the feet with soap and lightly massaging the skin until it becomes pink and warm in the bath; (d) rubbing the skin with alcohol when the signs of restored circulation (reddening) appear; (e) placing a sterile bandage on the affected area.

Toughening

By toughening is meant a set of measures aimed at increasing adaptability to abrupt changes in temperature and the ability to endure prolonged cold, wind, snow, rain, etc., without injury to health. Toughening makes the body more resistant to respiratory infections, favorably affects metabolism and blood composition, and is the best means of preventing skin diseases.

A. V. Suvorov regarded toughening as extremely important. He systematically toughened himself and developed striking powers of endurance to cold, heat, and all the rigors of life in the field.

The toughening process is essentially a matter of making increased demands on the body through exposure to sun, air, and water. The latter are employed throughout the military training period with due regard for the time of year and nature of the branch of service.

Physical exercise is taken in the open in light clothing (in trunks during the summer) throughout the year. The feet are washed with cold water whether in the barracks or in the field. Washing in the morning with cold water stripped to the waist should be the practice of every soldier wherever he may be. A day of work or sports should end with stripping and washing the trunk or with a shower. While brushing the teeth, the mouth and throat are rinsed with cold water. In the summer the order of the day includes bathing on the completion of drill and before dinner.

Sun and air baths may be taken only in free time or on days off. The sun and air can be used for toughening purposes in camp without interfering with combat training. Some housekeeping duties (e.g., cleaning of the grounds) can be performed in T-shirts alone without tunics and, weather permitting, with bare waist. Only trunks are worn in sports and during exercise.

Systematic toughening improves thermoregulation by conditioning the thermoregulatory nerve apparatus. It is based on the formation of conditioned reflexes which enable the body to adapt to changing environmental conditions, sharp variations in temperature, cold and heat. The following principles must be strictly adhered to in setting up a toughening program: (1) continuity of the measures, especially those involving water; (2) gradual decreases in temperature of the water used for washing the feet; (3) gradual lengthening of the time spent in the water while bathing; (4) gradual lengthening of the time spent in the sun and in the air wearing trunks alone.

If the program is interrupted for any length of time and then resumed, it must be done in a gradual and systematic manner. Men reporting for training from an area with a different climate follow a special program under medical supervision. Doctors give individual attention to those soldiers who have recuperated from a serious illness, especially of respiratory character, and to those who have not adjusted to sun baths or cold water procedures.

Two things have to be kept in mind in regard to the toughening process -- only the heated body is to be wetted or dried; after a water procedure the body must be carefully dried with a towel.

In the summer bathing starts with a water temperature of 15 to 16° and no more than one or two minutes in the water. Bathing is discontinued when the water temperature drops to 13°. If the water cools suddenly, the bathing goes on, but the time spent in the water is shortened.

The effect of cool air on the skin is comparable to that of water, i.e., it first constricts and then dilates the blood vessels of the skin.

The most valuable means of toughening is physical exercise outdoors. In the summer the men exercise in all kinds of weather in trunks and barefoot (or wearing sneakers); in the fall and winter with bare torso when the air temperature is +5°, in undershirts at -3°, and in tunics below -3°.

Sun and air baths may be taken when the air temperature is no lower than 16 to 18° and there is no wind. The initial exposure lasts 15 to 20 minutes; the time is gradually increased to 1.5 to 2 hours. For older officers the temperature and length of exposure to the sun are determined by the doctor in accordance with their condition. The baths are halted for two or three days if the men become painfully sunburned.

The toughening program is executed under the supervision of medical personnel. It is drawn up by the senior medical officer of the unit jointly with the physical training instructor.

Skin Care

The use and maintenance of military and transport equipment inevitably results in dirtying with oily and inflammable materials the clothing and skin of the soldiers handling them. This specific type of dirt is in addition to the dirt that is inevitable in field operations both in peacetime and in wartime. Dirt and irritation of the skin combined with minor traumas create the precondition for the development of pyococcal diseases (boils and furunculosis, hydradenitis, carbuncles, abscesses, phlegmon, paronychia).

An analysis of pyodermas shows that a variety of factors are responsible, chiefly those decreasing skin resistance to pyogenic infections (oils and liquids tending to dry and crack the skin, irritants, etc.). Seborrhea contributes to the development of deep pyodermas. Heavy perspiration due to physical labor or high air temperature, intense infrared radiation, etc., is another predisposing factor. Soldiers frequently lie on the ground during field exercises. They are exposed to dirt in trenches, blindages, and dugouts. Cold and dampness, contact with machines, equipment, and weapons are other sources of contamination. Dirty clothes often cannot be properly laundered or

mechanically cleaned. The lack of facilities for showering, the inability to change one's underwear and uniform or work clothes, etc., may also cause skin diseases.

Effective measures to control these diseases can be devised and implemented if the causes are correctly understood. The senior doctor of a unit and his assistants are responsible for: (1) preparation of sanitary and technical measures; (2) execution of sanitary and technical measures; (3) arranging for the treatment of those affected with minimum interruption of combat training; (4) hygiene education.

The first group includes elimination of the causes of minor traumatism, elimination or mitigation of the effects of contact with substances dirtying or irritating the skin, and timely treatment of minor skin injuries.

To combat purulent infections, it is very important to treat minor traumas promptly, for they frequently result in abscesses, paronychia, and phlegmon. They may be smeared with a 1% solution of brilliant green, methylene blue, and gentian violet or 2% tincture of iodine.

Minor injuries have been successfully treated in recent years with N. V. Novikov's fluid consisting of: tannin - 1 g, brilliant green - 0.2 g, 96° ethyl alcohol - 0.2 g, castor oil - 0.5 g, and collodion - 20 g. The fluid dries within two minutes after it is applied to the skin, forming a thick, long-lasting film.

I. I. Paykin has suggested that complications resulting from minor traumas can be prevented by treating the hands at night with a 0.5% solution of ammonium hydroxide and then applying vaseline. The concentration of ammonia is gradually increased to 0.75% while the period of treatment is lengthened to 2 or 3 minutes. The thin film of vaseline is retained until morning.

The paste KhIOT-6 is used as a protective ointment against a variety of skin irritants -- coal-tar and petroleum products, mineral and vegetable oils, paints and lacquers, and powdered substances insoluble in water and glycerin. The paste contains gelatin - 2.4 g, starch - 5.6 g, glycerin - 72 g, Burow's solution - 2.0 g, and distilled water. It is washed off with cold water before eating and after work. The burning and reddening at the cracks and lesions quickly passes. The hands must not be wiped with rags during work.

Hands can be protected against water and aqueous solutions by Professor Selisskiy's zinc-stearin ointment consisting of zinc oxide - 3 g, stearin - 12 g, oil (vegetable or mineral) - 85 g. The ointment is rubbed into the skin before the start of work (once a day). It is a protection against aqueous solutions of acids, alkalis, and chromium salts.

Rakhmanov's paste is effective in removing technical oils, mazut, paint, and carbon black. It consists of ordinary (rather than white) clay - 1.5 kg, river sand - 0.25 kg, kerosene - 0.25 liter, water - 1 liter, sulfuric acid (technical - 65 to 66%) - 75 ml (or oil

of vitriol - 92 to 93%) - 50 ml. The ointment is prepared by grinding the clay with the sand and kerosene and then mixing the sulfuric acid with the water drop by drop. As the mixing continues, the acidified water is gradually added to the first mixture of clay, sand, and kerosene. The skin is washed two or three times. Rakhmanov's paste does a quick and thorough job of cleaning the hands without irritating them.

Abrasions and Methods of Controlling Them

Abrasions are a form of dermatitis caused by mechanical irritants unlike dermatitis which is of chemical or thermal origin. They are pathological changes in the skin resulting from prolonged friction or pressure of clothing (especially shoes) or equipment. The site exhibits uniform redness (focal or diffuse erythema), then slight swelling and edema. Subjectively, the symptoms are accompanied by a burning sensation and tenderness in the affected area. Continued friction results in blisters of various sizes, erosion, excoriation, and ulceration of the skin.

According to veteran army doctors, erythema, blisters, pustules, abscesses, erosion, and excoriation have an acute course; the other kinds of abrasions (ulceration, chafing, corns, callosity, etc.) are chronic.

Three stages of abrasion are distinguished clinically: inflammatory redness, blisters, erosion, and ulcers.

Small blisters are usually resorbed without marring the skin. Larger ones are lanced, leaving the surface without an epidermal layer. Second- and third-degree abrasions are frequently complicated by purulent infections.

An analysis of abrasions among soldiers, especially infantrymen, shows that the feet are most frequently affected. They are fairly rare elsewhere: in the small of the back, on the shoulders, inner surfaces of the thighs and buttocks (in the cavalry). They are common among bicycle and motorcycle riders. Parts of the foot mostly affected among riflemen include the toes, sole, heel, region of the Achilles tendon, inner and lateral surfaces, and back. Abrasions develop very rarely on other parts of the foot.

Abrasions are not only painful when walking and prevent the sufferers from moving about, but they also substantially increase the expenditure of energy per kilometer traveled.

Experience has shown that complex abrasions require an average of 25 days to heal, light abrasions (which constitute about one-third of the total number of cases) about 5 days.

The attempt to find a single cause of abrasions among soldiers was, as one might expect, unsuccessful. Research revealed that several factors and conditions usually operate together: (1) poor shoe design; (2) various defects in the sewing; (3) improperly fitting boots or shoes;

(4) walking a long distance in uncomfortable shoes; (5) delayed and poor quality repair work; (6) clumsy use of puttees; (7) incorrect use of insulating materials (newspaper and wrapping paper, insoles of various kinds, etc.); (8) abnormal foot structure; (9) deformed toes and nails; (10) corns on the toes, callosity of the sole and sides of the foot.

Predisposing factors include excessive sweating of the feet, lack of water-resistant shoes, and improper care of the feet.

It has been discovered from observation that, other things being equal, abrasions occur six times more frequently among soldiers who sweat profusely than among those who don't. Abrasions on the shoulders, small of the back, and thighs due to friction and pressure of equipment and clothing generally occur only when the skin and underwear are damp. It has also been observed that marching in the rain over muddy roads in shoes needing repair causes more abrasions than when these conditions are not present. Sweat evaporates with difficulty on a hot, windless, humid day and thus promotes the formation of abrasions. So too the wearing of airtight shoes with rubber soles, which make the feet sweat more than usual. Finally, the failure to care for the feet properly weakens the resistance of the skin to mechanical pressure, thereby increasing the number of abrasions.

Adequate training for walking and toughened skin are very important in preventing abrasions. Persons accustomed to walking barefoot are less sensitive to external irritants than those with tender skin who avoid going about barefoot.

Profuse sweating of the lower extremities is caused by the abundance of sweat glands in the soles of the feet as compared with other parts of the body. According to Krause, the soles have 336 sweat glands per cm^3 of skin, the palms - 373, back of the foot - 126, thigh and shin - 79, back and buttocks - 56. This is the reason why it is necessary to practice good hygiene of the feet and shoes.

According to P. Kofman, the reasons for abrasions of the feet among soldiers are distributed as follows: poor shoe design - 47%, improperly fitting shoes and boots - 19%, defects in the manufacture of shoes - 14%, clumsy use of puttees - 12%, abnormal foot structure - 3%, other defects - 5%.

A. Verbov maintains that the causes of abrasions are ill-fitting shoes, clumsy use of puttees, corns, shoe defects, and abnormal foot structure in this order.

During World War II one of the supply units noted that the main cause of abrasions was too large shoes (about 35% of all the abrasions). Excessive sweating, clumsy use of puttees (about 15%), tight and unrepaired shoes (20%) were other causes.

An analysis of the cases shows that so-called external factors were responsible for about 85% of all the abrasions, those of internal or endogenous origin were responsible for only 15% of the cases. Clinically, the most frequent forms are bullae (about 75%); then come erosions (about 20%), the remaining 5% being erythema and ulcers.

All the factors responsible for abrasions can be completely controlled by the resources available to the medical service and commanding officers. The most important measures are foot care and treatment of hidrosis. In addition to general treatment, astringents, desiccants, and disinfectants are useful for local application.

Insulating the feet with paper on a winter march is contraindicated. The paper quickly disintegrates and causes abrasions. An extra pair of puttees definitely should not be used to keep the feet warm. It is far better to insert insoles of leather, heavy cloth, felt, or cardboard, etc., if the shoes are large enough. In the summer, insoles of any material should also be inserted in such shoes; it is absolutely forbidden to wear two or more pairs of puttees.

All soldiers should be taught the proper way of putting on puttees because they may cause abrasions, even in properly fitted shoes, if clumsily wound around the legs.

Abrasions should be treated as soon as they are noted. Otherwise, blisters are certain to develop which will have to be opened. A pyogenic infection is a likely complication. On a march the early application of a bandage to prevent further rubbing by the shoe is essential. A. N. Igumov has strongly recommended a colloidal elastic dressing for this purpose. The colloidal fluid contains: (1) zinc oxide in powdered form - 1.0; (2) castor oil - 5 drops; (3) vaseline - 3 drops; (4) collodion - 20.0 (added after the other ingredients have been carefully mixed together). The dressing is applied with a brush to the skin near the mucous bursa of the head of the first metatarsal bone and stays in place for two or three days.

Proper shoe care is essential in preventing abrasions. Shoes should be removed, dried, and stretched as soon as the site of a night halt or major stop is reached. If possible, the puttees are washed or rinsed and carefully dried. Excessively perspiring feet are washed in cold water and then smeared with a 2% solution of formalin. A 1% solution of formalin in ether or a 2% solution of salicylic acid in alcohol is recommended for very sensitive skin.

Prevention of Epidermophytosis

This infection, to judge by the literature, has recently become prevalent in foreign armies.

According to I. N. Bogdanskiy, 0.8% of the soldiers who passed through the polyclinic of the Moscow garrison in 1946 suffered from epidermophytosis. More urban than rural dwellers are affected. More cases occur among those who are unable to go barefoot or who avoid doing so than among those who take off their shoes when the weather is warm. A. S. Rozenfel'd's data indicate a morbidity of 6 to 14% of the urban population examined, only 0.15% of the rural population of Leningrad oblast and Karelia.

The role of baths in spreading epidermophytosis can be appraised from the high incidence of the infection among attendants. Rozenfel'd found occurrences in 30 to 40% of the public bath attendants when he examined. The causative agent, his mycological investigations revealed, was Epidermophyton. Pure cultures of Epidermophyton Kaufmann-Wolf were isolated from bath waste water. Moreover, mycelium kept in a test tube of this water not only did not die, it even showed signs of growth for 12 months.

In the armed forces epidermophytosis is commonest among sailors (particularly submariners), tankmen, and infantrymen. Dermatologists believe that maceration of the skin of the feet is a predetermining factor.

Infection by the fungus occurs after exchanging objects of personal use (shoes, socks, puttees), Particularly harmful in this respect are the fiber brushes that are passed on from one soldier to another, sometimes without being disinfected.

N. Sinani is right in maintaining that epidermophytosis is one of the commonest skin diseases of soldiers. It impairs their health and decreases their efficiency.

The principal prophylactic measure is strict sanitary inspection of the baths, showers, and swimming pools plus periodic disinfection of the wooden grates, benches, bath tubs, and, above all, fiber brushes.

Rozenfel'd recommends the following solutions for disinfecting baths and equipment: chlorinated lime (10 mg/1 of active chlorine) - 4%, phenol - 1%, chloramine - 4%, naphthalysol - 3 to 5%. The disinfectant takes at least two hours to be effective. The fiber brushes should be boiled for 10 to 15 minutes. It is absolutely forbidden to wash puttees in a bath in order to avoid infecting the benches and equipment.

Strict observance of traffic rules and mandatory separation of undressing and dressing sections are extremely important in controlling epidermophytosis.

In the barracks exchanging worn puttees and socks without first washing them is absolutely prohibited. Before shoes and boots are reissued, they should be disinfected by pads soaked in a 5 to 7% solution of formalin and kept in the shoes for two or three days.

Combatting of excessive perspiration, early discovery and treatment of latent forms of epidermophytosis are important control measures.

Sanitary Processing in Connection with Decontamination

By "sanitary processing" is meant the removal of radioactive substances from the skin and visible mucous membranes. During a war sanitary processing is effected at the same time that shoes, clothing, equipment, weapons, and antichemical facilities, etc., are decontaminated. Radioactive substances are removed by means of dry pledgets, water, snow, and liquids from individual antichemical packets. A 2% solution of sodium bicarbonate is used on the mucous membranes.

Sanitary processing may be partial or total. Partial processing is the washing of exposed parts of the body and the eyes along with rinsing of the mouth and throat. Partial processing is indicated for those who have been in a contaminated area. On orders, the soldiers do their own processing. Total processing is indicated when there has been mass contamination.

Total sanitary processing includes washing the entire body with hot water and soap and applying a 2% solution of sodium bicarbonate to the mucosa of the eyes, mouth, and throat. All the clothing, shoes, equipment, and weapons are decontaminated at the same time. If necessary, badly contaminated clothing and shoes are replaced. During a war special processing points are set up with compulsory monitoring.

Total sanitary processing is effected at special points set up by the chemical service or individual military units. They are occasionally set up near a warehouse using the resources of the latter or those of the chemical service.

A distribution point and several areas are organized at the special processing points to handle the personnel and decontaminate the clothing, equipment, antichemical facilities, weapons and combat material. A monitoring post placed at the entrance to the dressing section checks the completeness of the processing.

Since a good deal of water is used, the processing area is located near a body of pure water. Access roads are important in cutting out traffic moving in the opposite direction and avoiding possible contamination of people who have been processed.

Effective decontamination requires the processing area to be divided into a clean section and a dirty section carefully separated from one another. The personnel pass in succession through the undressing part, monitoring post, showers, and dressing part. If the weather is cold, the processing takes place in closed, heated rooms or in tents. In the summer, uncontaminated streams are used for this purpose.

Total sanitary processing is reserved for those who after undergoing partial processing are found to have clothing and exposed parts of the body contaminated beyond permissible limits. Wounded, shell-shocked, and burned soldiers reaching medical evacuation areas from contaminated regions are processed completely and their clothing and footwear decontaminated at aid stations.

Persons working in sanitary processing and decontamination areas use rubber boots and gloves, reliable gas masks, aprons or protective overalls. When their work is over, they too undergo sanitary processing.

When the processing area is closed, it is monitored for radioactivity. If the permissible level is exceeded, earth is strewn over it, time permitting; otherwise the drainage ditches are filled up and warning signs posted just outside the area.

CHAPTER X

HYGIENE OF CLOTHING AND FOOTWEAR

The basic function of clothing is to regulate the processes of heat emission. Clothing helps the body to adjust to changes in the weather.

The wind-resistant properties of clothing are highly significant in the northern parts of our country, especially in the Arctic. A mountainous climate, which is marked by abrupt changes in temperature during the day and at night and by strong winds, also makes great demands on clothing.

Well produced clothing facilitates the preservation of the body's temperature equilibrium in the winter. Less heat is emitted when one wears garments made of closely-woven heavy cloth in several layers, which create an artificial climate around the body.

The main factor determining the physiological reactions of the organism is the degree of coolness, which varies with the seasons and force of the wind. If the temperature in one's home can be modified as desired by heating, then the clothing, which merely controls heat emission from the skin, need not be changed during the different seasons of the year even if the temperature drops abruptly.

Well sewn and correctly fitting uniforms do not hamper breathing or interfere with normal blood circulation or heat exchange. Properly styled uniforms are airy and promote the rapid evaporation of perspiration.

Finally, clothing should be water-resistant, i.e., it should be able to keep water out and retain its hygienic properties after being wet and then dried. Well dressed leather is known to be virtually impervious to moisture.

Uniforms should be made of several layers of fabric in order to: (1) minimize the loss of heat by radiation; (2) increase the amount of air confined by the cloth; (3) change the ratio of volume of air to solid substances; (4) admit more air; (5) facilitate the passage and emission of moisture into the air.

The wind resistance of clothing is increased by using microporous material in the outer layer or waterproof cloth. This is essential in the North or in mountainous regions. Wind-resistant fabric produces a microclimate under the clothing that has a highly favorable effect on man's sense of well-being and his efficiency.

Yu. V. Vadkovskaya has shown that in certain northern regions most bodily heat is lost as a result of the wind -- which may attain a velocity of 20 to 25 m/sec (72 to 90 km/hr) -- blowing through the clothes. This wind pressure, which blows away the warm air next to the body, must be opposed by a wind-resistant layer in the uniform or by a special wind-resistant suit worn over it.

While performing a variety of complicated functions, clothing must not impede normal perspiration. It is important, therefore, that the fabric allow air to pass through. This determines the effectiveness of ventilation as well as the amount of heat lost from the body.

"The function of clothing is evidently not to remove the outer air from the body of a clad man, but to make the inflow of fresh air imperceptible, not burdensome," said F. F. Erisman, stressing the importance of fabrics and clothes that let air in.

It would be a great mistake, however, to require that all fabrics possess a high degree of permeability to air, for the wearing of winter or summer clothes made of such materials would result in abrupt cooling of the body by the inflow of cold air and removal of warmth from the skin.

The effect of water on cloth used for uniforms has great practical significance. It has been shown that a uniform may triple in weight after it gets wet. Moreover, wetting also (1) changes the ratio of air volume to solid substances; (2) increases heat conductivity; (3) decreases air permeability; (4) weakens its heat-insulating properties. As the water absorbed by the cloth evaporates, the body loses considerable heat because 540 calories are expended on the evaporation of every liter of water.

The use of organic silicon compounds is a very promising approach to the problem of making uniforms water-resistant. The water-resistant properties of materials treated with silicones result from the formation of a very fine film of a silicon polymer that cannot be wetted. Fabrics impregnated with silicones repel raindrops and streams of water. According to M. G. Voronkov and B. N. Dolgov, such fabrics let water through only at a pressure of 30 to 50 cm water column. Their ability to absorb water decreases about twentyfold, and their properties remained unchanged even after prolonged exposure to boiling water or hot organic solvents. The most important feature of silicone-impregnated cloth is that it permits the passage of air even when it is raining. Therefore, garments woven from it are as airy as those woven from untreated cloth.

Color is an important hygienic factor for troops stationed in southern latitudes. The ability of clothing to absorb the visible rays of the sun depends as much on their color as on their materials. Fabrics of different color differs in degree of relative absorption of heat in this order: white - 150, light yellow - 102, dark yellow - 140, dark green - 161, red - 168, dark brown - 198, and black - 208 (Pettenkofer). Woolen fabrics radiate and absorb more heat. Wet fabrics radiate approximately 35 to 50% more heat than do dry fabrics.

Of even greater hygienic significance is bacterial and parasitic contamination of clothing. Together with dirt and dust a great quantity of bacteria, including pathogenic varieties, settle on clothing, retaining their viability and virulence for periods of time ranging from a few hours (gonocci) to 50 to 80 days (the typhoid bacillus).

The ability of uniforms to absorb gases is another important factor. It was discovered during World War I that uniforms were frequently the cause of gas poisoning. It was shown experimentally that gases condense on the threads and fibers. A portion of the gases become chemically bound with the fabric; a smaller portion remains in the pores. P. Vasil'yeva observed that the taking up of chlorine, phosgene, or sulfur dioxide by fabric is a typical process of adsorption. The amount of the latter varies with the concentration of the gas, degree of moisture of the fabric, and nature of the fibers. Woolen fabrics absorb more gas than do cotton fabrics and liberate them more slowly.

The uniforms of ski troops have the following special properties: (1) low heat conductivity; (2) good permeability to air and perspiration on marches and wind-resistance at halts; (3) moisture-resistance; (4) looseness, not hampering movement; (5) careful fitting to avoid difficulties in breathing and blood circulation; (6) light weight.

The outfit of mountain troops requires special attention owing to the strong winds and abrupt changes in temperature (between sunshine and shade, between day and night). In addition to cotton or woolen sweaters they must have ponchos. It is particularly important that the clothes be loose. Knitted woolen helmit liners are good protection for the head, neck, and face against the cold.

Due to the conditions under which tankmen and mechanics have to operate, especially in the summer, clothing next to the skin is likely to be a source of irritation. Oil and greasy materials soil the clothes and the skin. In the winter the men get very cold when servicing or repairing tanks in the open. Many of their skin diseases are due to chemical irritants found in the oil and grease which clog the follicles of the sweat glands and dry out the skin. Tank personnel are furnished with special overalls, jackets, and trousers to enable them to work in comfort while protecting their skin. Ordinary overalls are most satisfactory in the summer; cotton jackets with hoods and trousers are best in the winter.

Hygienic Requirements for Footwear

The hygienic requirements for army footwear stem from its purpose -- to protect the feet of the soldiers against cold and dampness, to keep them clean, and to prevent injuries. At the same time the footwear must not hinder normal heat exchange; it must repel moisture, oil, decomposition products of sweat, and other substances excreted by the skin. The design must match the anatomic configuration of the foot. Normal blood circulation must be retained in the feet during walking, running, and prolonged standing. Well constructed and correctly fitted shoes prevent foot injuries on a march, during field exercises and maneuvers.

In a modern war involving atomic and chemical weapons shoes must protect the feet against poisoning by gas and radioactive substances. The materials used in making shoes will have to be able to withstand

repeated degasification and decontamination, retaining both their shape and protective properties. If necessary, the shoes will have to go through chamber and chemical disinfection.

In the winter army shoes have to insulate the feet against the cold. This can be done if the materials are properly selected and styled and insoles, woolen puttees, etc., used. Well fitted shoes are essential in preventing frostbite.

Army footwear must also be water-resistant. Experience has taught us that damp cold is the main cause of "trench foot." The use of non-waterproof and inflexible materials promotes the formation of abrasions. Poor design is the principal factor in injuries of the feet and toes and in the development of corns and callus. Consequently, good style and workmanship are essential. Unfortunately, from the hygienic point of view these demands are not met.

These requirements are not satisfied as far as penetrability by air and moisture is concerned. This feature causes excessive perspiration, chafing, and to some extent, epidermophytosis. The reason is that moisture accumulates in the boot due to difficulty in getting rid of sweat and to inadequate ventilation of the feet. In the summer moisture causes abrasions; in the winter it promotes supercooling and the development of frostbite.

It would be wrong, however, to attribute excessive perspiration and chafing solely to poor design and use of non-porous materials. Research has shown that the escape of moisture from shoes depends on permeability of the material to air and construction features of the shoes.

The main defect of rubber-soled shoes is that they make the feet perspire too much. Daily observations have shown that rubber and similar leather substitutes tend to make the feet moist.

P. V. Ramzayev proved that sweat cannot escape by the circulation of air, the amount of which is virtually nil. The author thinks that another approach is more promising — to increase the permeability to moisture of the materials employed in making the shoes.

P. Ye. Kalmykov's investigations indicate that many leather materials are highly permeable to moisture, but not to air. According to G. V. Rodionova, Russia leather is less airy than kersey; the reverse is true for the moisture permeability of leather (4 to 5 $mg/cm^2/hr$) and kersey (0.3 $mg/cm^2/hr$). Ramzayev maintains that leather is the most permeable of all, admitting about 20% of the moisture, kersey only 5%. The chief defect of leather substitutes, therefore, is their low permeability to moisture.

Ramzayev maintains that the hydroscopicity and moisture capacity of the materials used in making shoes is extremely important in preventing excessive perspiration of the feet. He has shown experimentally that the direct passage of moisture through the materials is an insignificant factor.

Kersey boots, in Ramzayev's opinions, are inferior to leather boots not because of the difference in permeability to moisture, but because kersey is incapable of absorbing much perspiration. Any leather substitutes must have considerable hydroscopicity and moisture capacity. In addition to these two properties, shoe materials must be water-resistant. It is difficult, but by no means impossible, to reconcile these two contradictory requirements. Of great importance too are proper care of shoes and keeping them clean, dry, and oiled.

The problem can be solved by using impermeable materials. It has been shown that army boots admit water through the seams and, in particular, at the places where the forepart joins the sole. According to Ramzayev, boots become soaked soon after immersion in 15 cm of water and within two to six hours at a depth of 3 cm.

P. Belkin says that boots placed in water become wet in a few minutes. The water enters through the seams and at the places where the upper part joins the sole. In time the leather becomes defatted, the result being more ready penetration by water. The amount of fat in the leather of the forepart drops from 25 or 28% to 10 or 12%. The leather can again be rendered impermeable by greasing it.

Shoes are now manufactured from leather treated with silicones. Such leather is water-resistant, does not putrefy, or become moldy.

Those shoes are considered hygienically perfect which are designed in accordance with the anatomy of the foot. The sole — the main part of a shoe — is cut out in such a way that there is sufficient room for the big toe, which plays an important part in walking.

If the shoe is too short, the foot cannot stretch out in walking, especially in marching. This causes the toes to bend at the joints (between the first and second phalanges and between the second and third phalanges) and makes corns develop. If a short shoe is worn for too long a time, the big toe turns up and out and abrasions result.

A narrow shoe exerts pressure in the region of the head of the first metatarsal bone. Again the result is abrasions, sometimes inflammation of the mucous bursa. A narrow shoe promotes cooling of the foot, pinches the blood vessels, and interferes with blood circulation. By causing the blood to congest it makes the foot perspire more freely and predisposes it to frostbite.

If the shoe is too large, the foot moves about too freely and the puttee becomes loose, the resultant folds contributing to the development of abrasions.

All this explains the importance of carefully fitting shoes to the foot.

The foot size can be determined with a wooden ruler that can be easily made locally. A measuring tape marked off in millimeters is used to measure the circumference. The data are recorded in the company list for fitting shoes.

Shoes are fitted on to feet wrapped with two new puttees (summer and winter). The insoles are removed because they are intended to be worn during warm weather when only the summer puttees are used.

Properly fitted shoes are easy to put on and to take off. They do not press against the feet and they have a space between the toes and tip that can be felt from the outside. Neither the big toe nor the one next to it touches the tip. When one rises, the shoes do not press against the back of the foot. The leather of the forepart does not wrinkle when held with the fingers. The fit is tested by walking.

Shoes and boots are manufactured for the army in nine sizes (from 38 to 46 inclusive) and three widths (narrow, medium, wide). Felt boots come in six sizes; they are tried on when both the summer and winter puttees are wrapped around the feet.

Wearing and Caring for Puttees

Improperly worn puttees are one of the main causes of abrasions. Giving instructions on how to put on puttees is a duty of unit leaders and medical personnel.

During warm weather generally only a single pair of cotton puttees is worn with an insole in the boot. At other times two pairs — cotton and woolen — are worn together to keep the feet warm.

The cotton puttees are wrapped around the bare feet first, then the woolen ones. This method prevents irritation and helps to prevent the woolen puttees from becoming soiled by skin discharges. During the first week that new shoes are worn the spare puttees should be wrapped around the lower part of the skin.

If properly wrapped around the foot, puttees fit tightly with no wrinkles especially at the toes, heel, and crest, and they stay put. Any wrinkles at the back when rising should be smoothed out and an effort made to wrap them around the feet firmly but not too tightly so that they do not move when the shoe is put on.

No garters should be used to secure the puttees to the feet in order to avoid constricting the blood vessels and impairing circulation. It is important that the puttees remain in place while walking. If they become uncomfortable, the shoes should be taken off and the cause of the discomfort corrected.

Correct care of puttees prevents excessive perspiration, abrasions, and chilling in the winter. Therefore:

(1) They should be changed as often as possible;

(2) the ends should be interchanged to keep them from wearing out too quickly;

(3) they should be dried out during a night halt or stop, straightened out, and hung up because wearing damp puttees causes abrasions in the summer and predisposes to frostbite in the winter. Soiled and sweaty puttees should (if possible) be rinsed or washed, if only in cold water, before being hung up to dry. They are carefully softened up before they are worn again.

(4) they should be washed with hot water and soap as often as possible, thoroughly dried, and rolled out or softened with the hands;

(5) young soldiers are to be taught the correct way of putting them on by NCO's, feldshers, and medical instructors.

Clothing as Protection against Luminous Radiation

In an atomic explosion about one-third of the energy liberated comes from luminous radiation lasting three seconds. The biologically active ultraviolet radiation takes place during the first 0.015 sec.

The direction of the rays of the luminous flux and values of the light pulses following the explosion of a medium-size A-bomb in the air under different weather conditions are shown in Figures 53 and 54 (M. Gvozdev and V. Yakovkin).

Luminous radiation is dangerous for man only after an air burst; the injurious effect of luminous radiation following an underwater or underground blast is negligible.

It is a well known fact that the surfaces of various bodies absorb luminous radiation and become heated in proportion to the intensity of the luminous flux. Dark-colored objects heat up quicker than do white ones and rough surfaces quicker than smooth and polished ones.

The intensity of luminous radiation is expressed by the number of calories received by 1 cm^2 of surface for 1 second.

As noted above, luminous radiation is emitted for 3 seconds. Consequently, the total energy of luminous radiation striking a unit of area will be approximately three times as great as the intensity of the luminous flux.

Tables 34 and 35 present critical energy values and data on the nature of the effect of luminous radiation at different distances from an atomic blast. The second and third columns in Table 35 show the distances with 20 km and 10 km visibility (A. Bibergal' and U. Ya. Margulis).

TABLE 34

Distance from the blast site	Total energy of luminous radiation per unit of area, in cal/cm^2	Intensity of luminous radiation, in cal/cm^2 sec
700	100	30
1000	50	16.7
2000	8	2.66
3000	2.5	0.835
4000	1	0.33
5000	0.4	0.13
6000	0.2	0.07
8000	0.06	0.02
10000	0.02	0.007

TABLE 35

Type of effect	Critical energy, in cal/cm^2	Distance from site of explosion where indicated effect is possible, in m: with visibility of 20 km	with visibility of 10 km
Moderate skin burns	3	3300	2600
Light skin burns	2	4,000	3200
White paper scorches	10	2100	1800
White paper chars	8	2300	2000
Black paper scorches	3	3300	2600
Black maple chars	8	2300	2000
Black maple scorches	25	1400	1260
Gray cotton cloth is singed	8	2300	2000
Gray cotton cloth scorches	10	2100	1800
White cotton cloth is singed	10	2100	1800
White cotton cloth scorches	17	1700	2460
Green gabardine scorches	10	2100	1800
Synthetic rubber scorches	8	2300	1000
Bakelite chars	75	800	770

In Hiroshima and Nagasaki burns caused by luminous radiation were observed only on the side of the body facing the epicenter of the blast. The portions of skin protected by clothing were largely unaffected. Skin burns occurred when the cloth adhered to the body. Multilayered clothing provided, as a rule, good protection against burns. Persons wearing many-colored clothes suffered burns in the areas covered by the dark tones.

Screening serves as a protection against luminous radiation. If a bomb "does not see" a person, it does not cause light injury.

Properly selected clothing (in several layers, loose, light colors) is another effective means of protection. White clothing protects a person against burns at a distance of 1,500 m from the epicenter. Soldiers can be protected by wearing a raincoat in the summer and a white camouflage robe in the winter.

The approximate value of light pulses following the explosion of a medium-size A-bomb is shown in Table 36 (N. Gvozdev and V. Yakovkin).

TABLE 36

Distance from the epicenter, in km	0	0.5	1	2	3	5
Value of the light pulse, in cal/cm^2	130	75	35	10	4	1

The value of light pulses in relation to the distance from the epicenter is shown in Figure 53; the role played by weather conditions is shown in Figure 54.

It will be noted that a light pulse of 0.3 cal/cm^2/sec causes slight pain. First degree burns occur with light pulses of 2 to 5 cal/cm^2, second degree burns - 5 to 10 cal/cm^2, third degree burns - 10 to 20 cal/cm^2.

Table 37 contains data on the igniting of materials by light pulses (M. Gvozdev and V. Yakovkin).

TABLE 37

Material	Light pulse, in cal/cm^2 charring	steady burning
Canvas	30	40
Light cotton cloth	4-6	8-10
Dark cotton cloth	2-3	4-6

It is evident from the table that dark clothing is half as resistant to light pulses as light colored clothing. This is clearly shown by canvas and tarpaulin sewn from the same material.

Multilayered winter clothing also provides good protection against burns, although it may char or ignite if close to the epicenter of a blast.

Decontamination of Clothing

Decontamination may be partial or total. Partial decontamination of clothing and equipment is carried out in the contaminated region or as soon as one leaves it. The clothing and equipment are not removed in the process. The outer clothing is freed from radioactive substances by someone shaking it off while wearing a gas mask and gloves. In the winter clothes, shoes, and equipment are rubbed with clean snow. After leaving the contaminated region the clothing is shaken out and brushed while the equipment is wiped with wet rags or washed with water.

Total decontamination is carried out at washing-decontamination points. Brushes, sticks, and water are used for this purpose; wads of cotton soaked in detergents or benzene help to remove grease stains.

The clothes are monitored after decontamination. If they turn out to be more strongly decontaminated than permitted by safety considerations, the process is repeated. If this too is futile, the clothes are sent to a special decontamination laundry.

Degassing machines, motor pumps, hydraulic hose, brushes, brooms, sticks, oakum, rags, and straw packing materials are used for decontamination.

The decontamination point is set up in accordance with local conditions (the tactical situation). Every point is divided into two areas. The first has two tables or places to decontaminate shoes and gas masks and a storeroom for clothes that do not need to be decontaminated.

The second area is divided into two parts, a "dirty" part and a "clean" part. The first is for the clothes and shoes to be treated. In the clean part the people put on their own (decontaminated) underwear and outer clothes or receive other clothing instead. The technicians stand here with his beta-gamma radiation meter. The people take a shower on the way from the "dirty" part to the "clean" part.

Clothes are separated into three piles before being laundered. The first includes items contaminated by alpha-active substances, the second - items contaminated by beta- and gamma-active substances, the third - items contaminated by radioactive substances and mineral oils. Clothes are grouped by degree of contamination depending on the amount of alpha and beta decay per minute usually from an area of 150 cm^2.

Degassing of Clothes

The density of contamination of uniforms and shoes varies with the kind of poison gas used, viscosity, size of drops, time of year, and weather conditions. Of significance too are the properties of the material, which determine the length of time it takes for the gas to penetrate and how deeply. In the summer gas may evaporate, thereby decreasing the density of contamination; in the winter it stays longer.

Rubber and rubberized items may remain contaminated for a long time and are very difficult to decontaminate.

Lewisite goes through shoe leather in 5 to 10 minutes. The soles of army shoes are virtually gas-resistant. However, they may be the cause of contamination of the hands, clothing, and equipment. Contact injuries from the contaminated rubber soles of leather shoes and rubber boots are particularly dangerous.

Liquid gas can penetrate cotton and woolen fabrics within 1 minute, heavy overcoat fabric within 3 to 5 minutes, leather and sheepskin within 10 minutes.

The greatest danger to gassed persons and those near them is the absorption of vaporous poison by the clothing. According to G. V. Khlopin, a cotton army uniform weighing 7 kg can absorb 800 g of chlorine, which is equivalent to 956 liters of the gas. This amount of chlorine can poison 2,560 m^3 of pure air.

It is believed that the fumes of other poison gases can be absorbed as readily as chlorine, phosgene, and diphosgene. The danger of poisoning by the desorption of gas in small, inadequately ventilated shelters is very great. That is why it is essential to remove overcoats and sometimes even uniforms before entering a shelter. Boots, especially if rubber soled, can be a source of gas contamination in a shelter, so they should be removed and degassed before the wearer enters.

It has been suggested that army uniforms and clothing should be treated by adsorbing or neutralizing substances as a protection against the fumes of persistent poison gases. Such treatment would strengthen the protective qualities of the fabric.

Capes or sleeveless ponchos are fairly effective against liquid gas. Shoes can be made more resistant by putting stockings over them or by applying a special protective grease.

Fabrics are freed from gas by degasification using chemical or physical methods. The choice is determined by local conditions, primarily the military situation.

Cotton and linen fabrics are boiled in uncovered vats for at least an hour in the open or in ventilated laundries after which the underclothing and summer uniforms are washed and ironed. According to B. I. Predtechenskiy, at least 10 liters of water are required for each kilogram of dry weight of clothing.

Pieces that cannot be boiled (course woolens and cottons, leather, sheepskin) are exposed to chamber degasification and then aired for several hours or washed with warm water (this is essential after lewisite is used).

Degasification conditions in hot air chambers are outlined in Table 38 (according to Predtechenskiy).

TABLE 38

Type of clothing	Conditions of degasification			
	Air temperature in the room, °C	Volume of air exhausted in an hour	Time of degasification, in hrs.	Load per m^2 of chamber
Course woolen or cotton clothing	85-95	120-130	3	No more than 4 overcoats, sheepskin coats, cotton outfits
Clothing made from sheepskin or leather	60-65	"	6-8	No more than 4 pieces; 12-20 shoes or boots

Uniforms are degassed in special chambers in accordance with instructions.

Chemical methods of degasification are based on the use of substances that react with poison gases to form non-poisonous products.

Protective Clothing

Throughout history when man has had to face the danger of adverse environmental conditions he has evolved the idea of using protective clothing. That is how special suits for underwater and high-altitude use, asbestos overalls, antichemical suits, gas masks, etc., have come into being. Roentgenologists have been wearing rubber aprons and gloves impregnated with lead for a long time.

The wide use of ionizing radiation and radioactive substances by science and technology has naturally given rise to the idea of creating new kinds of protective clothing. However it has not been an easy thing to do. At present it is considered virtually impossible to prevent exposure to gamma rays and neutrons by means of protective clothing. Such clothing would have to consist of tens and possibly hundreds of kilograms of shielding materials. It has been estimated that a person weighing about 70 kg would require coveralls weighing 120 kg in order to reduce the intensity of gamma radiation by 50% (with the energy of 1 mev). Therefore, lead, concrete, etc., are used for constructing mobile and stationary screens to provide protection against gamma radiation and neutron flux.

Protective clothing can ward off injury by alpha and beta rays and by infrared and ultraviolet radiation. Light-colored clothing during the A-bomb explosions in Hiroshima and Nagasaka in 1945 provided protection within a range of 1.8 to 3.6 km (F. Holden and F. Owings).

Clothing is also good protection against radioactive fallout. It has been shown that the thin layer of air (2.5 to 5 cm) usually created by summer clothing can shield a person from alpha particles. Ordinary clothing substantially decreases the danger of injury from beta particles. According to Holden and Owings, light clothing lowers the level of radiation 86% with the beta-radiation energy of 0.2 mev, 40% with the energy of 0.5 mev, and 18% with the energy of 1 mev. With the beta-radiation energy of 3.0 to 3.5 meg light clothing only lowers the radiation level 3 to 4%. When heavier clothing is worn (weighing 29 mg/cm^2), the corresponding values rise to 99.82 and 39% (beta-radiation energy 0.2 to 0.5 and 1.0 meg). With radiation of 3.0 to 3.5 mev the decrease in beta radiation is 8 to 10%, respectively.

Beta-radioactive fallout is highly dangerous to man. If imprisoned by clothing, the danger is greatly lessened because the intensity of radiation is inversely proportional to the square of the distance from the source of the radiation to the surface irradiated.

Protective clothing and gas masks or respirators prevent disintegration products from penetrating the body. It must be remembered, however, that there is a danger of radioactive contamination through clothing worn or cleaned without strict observance of the rules for radiation safety. It is important, therefore, to be familiar with the rules for wearing protective clothing, to check on radioactive contamination of clothing, cleaning (decontamination) of shoes, gloves, gas masks (respirators), and other objects used to protect the individual.

The materials used in making protective clothing, shoes, gloves, and masks must be easily decontaminated. Sometimes they can be conveniently manufactured from cheap materials (paper and its substitutes), which can be destroyed (burned) if contaminated above the permissible level. Protective clothing is now made from polyvinyl chlorides and other synthetics. One of the main shortcomings of these materials is that they are airtight so that it is necessary to ventilate the space underneath. This is not the case with aprons, cuffs, etc.

Special protective clothing is not required in working with enclosed sources of radiation (gamma-ray materiology).

In working with tracer doses of radioactive isotopes, protection against radioactivity is provided by ordinary medical robes, film cuffs, and rubber gloves. If necessary, a plastic apron can be worn over the robe.

Working with comparatively large amounts of radioactive substances requires the use of special protective clothing — robes, half-overalls, overalls.

If the air is strongly contaminated by radioactive gases, dust, or aerosols, a lung suit with an air supply is used. The suit is designed to provide a microclimate satisfying hygienic requirements and enabling the wearer to work as long as he wishes.

The respirator, an important feature of protective clothing, prevents radioactive substances from entering the lungs by trapping them in filtering material. The face part must be accurately fitted.

Overalls, special shoes, and underwear are usually worn when radioactivity of over 10 millicuries is present at the working place. If the activity exceeds one curie, extra aprons and cuffs or polyvinyl chloride robes along with special sneakers are worn. The charwomen too wear rubber gloves, aprons, cuffs, galoshes or rubber boots.

If radioactive aerosols penetrate work places and laboratories, the personnel must put on masks and, if there are special indications for them, insulating oxygen devices.

Lung suits with air fed through a hose are used when the air is intensely contaminated by highly active substances. The material of the suits is easily decontaminated by acids and alkalis. A continuous air feed of 150 to 200 liters a minute provides the worker with normal conditions of thermoregulation.

Protective clothing is washed only in special laundries. Plastic suits are decontaminated in special places in accordance with instructions.

G. Wells' data indicate that cotton serge contaminated by aqueous solutions of fission products are best decontaminated at low pH values (4.5 to 6.5). Good results have been obtained using 0.5% solutions of ethylenediamine tetra-acetate, cyclohexylenediamine tetra-acetate, nitroacetic acid, and diethylenetriamine penta-acetate. Some 92 to 98% of the contamination is removed from the serge. The use of distilled water under these conditions lowers the activity of the fabric by only 66%.

Protective clothing is taken off when one leaves the laboratory for another place where there is no work involving radioactivity. Before eating or smoking the hands are washed and brushed three times with soap and water. A shower is taken if the body has been contaminated.

All laboratories working with radioactive substances have a special person or unit to monitor the personnel in order to prevent overexposure and penetration of the body by radioactive substances. Monitoring permits early detection and removal of contamination.

It is well to keep in mind that the means of antichemical defense available to troops (gas masks, respirators, capes, overalls, stockings, and gloves) are also helpful in countering radioactivity. Should these not be available, the following can be used: towels, handkerchiefs, cotton batting or gauze to protect the lungs; sacking, rags, or matting for the legs; mats of straw, reed, or twigs for bedding during combat operations on contaminated territory.

Whenever possible, a contaminated area should be left at great speed by car, armored carrier, or tank. Combat vehicles and trucks should move keeping the prescribed distance between them to prevent radioactive dust from falling on the personnel. Tank crews and drivers wear masks; the hatches are closed.

As soon as the contaminated area is passed, the protective equipment, clothes, and shoes must be removed, shaken, and beaten with due regard for radiation safety. If necessary, the various items are decontaminated using the unit's own resources or at special points followed by monitoring.

The maximum permissible levels of contamination by radioactive substances for certain objects are shown in Table 39.

TABLE 39

Objects	Contamination of 150 cm^2 in 1 min by alpha particles		Contamination of 150 cm^2 in 1 min by beta particles	
	Before contamination	After contamination	Before contamination	After contamination
Hands	75	background	5000	background
Special-purpose linen and towels	75	"	5000	"
Special-purpose cotton clothing	500	100	25000	5000
Film clothing	500	200	25000	10000
Gloves on the outside	500	100	25000	5000
Special-purpose shoes on the outside	500	200	25000	5000
Work surfaces and equipment	500	200	25000	5000

CHAPTER XI

DECONTAMINATION

Sources of radioactive contamination of the air following atomic blasts are found in: (1) fission products; (2) radioactive isotopes formed in the soil or water due to neutrons; (3) radioactive substances used in combat; (4) products of nuclear fuel, particularly plutonium 239, left unsplit.

Various steps may be taken to prevent persons and animals from coming into contact with contaminated objects: (1) removal of the contaminated material to an uninhabited locality for temporary isolation; (2) burial in the ground or in the sea; (3) decontamination of the contaminated surfaces of the material by mechanical or physico-chemical means. The method is selected on the basis of the value and size of the material, level of radioactivity, availability of technical means, etc. Sometimes it is advisable to keep a contaminated object until the activity falls off naturally.

It is better to burn cheap, strongly contaminated objects, if the radioactive smoke can be prevented from entering the atmosphere, and to bury in the ground the ash containing the radioactive concentrates. Small, strongly contaminated items of little value are buried in the ground. This is fairly common procedure with objects contaminated by long-lived isotopes.

During the first major tests at Bikini atoll the American aircraft carrier "Independence" was so contaminated that it would have been fatal for anyone to remain on the upper deck. Within two weeks the dose rate fell to 3 r a day; after a year the average dose dropped to 0.3 r a day. After three years the ship was used to house a naval radiological laboratory. This is an example of a gradual decrease in radioactivity without human intervention because no decontamination work was undertaken on the ship.

Radioactive substances generally settle on the surface of an object, although they sometimes penetrate the material if its structure is loose or if it contains many cracks and depressions. Such materials are unpainted and unpolished wood, brick, plaster, rope, woolen and cotton cloth, etc.

A neutron flux causes radioactive isotopes to be formed deep in any substratum. Thus, surface treatment of the object with decontaminating agents is useless.

Decontamination is essentially the process of removing the superficial layer of the material together with the radioactive contaminants. Chemical and physical agents are used for this purpose. In the former a reaction takes place with the formation of a soluble compound easily disposed of with water. If chemical decontaminants are to be successfully used, it is evident that one must know the composition of the radioactive substances contained in the radioactive dust or drops of the radioactive liquid. The isotope composition of fission products for different periods of time after an atomic explosion is well known.

By knowing the time that has elapsed from the moment of an atomic explosion one can use a chart to determine accurately the fission products present in the radioactive contaminants. If fission products are used as radiological warfare agents, the chemical methods of decontamination will obviously be the same as after an atomic explosion.

For the purposes of chemical decontamination it is important to ascertain that part of the total activity which is due to a given isotope. Complete removal of the latter entails a corresponding reduction of total activity.

We must emphasize the fact that the methods of chemical decontamination by means of organic salts and mineral acids are employed chiefly in laboratories and under industrial conditions. It is obviously not worthwhile to use chemicals for buildings, streets and squares, transport vehicles, etc. Simpler and cheaper means are available -- washing, wiping with wet rags or fiber packing (or straw), vacuum cleaners, sandblasts, etc.

In industry decontamination is carried out by means of special agents applied in the form of a jelly, paste, or liquid to a contaminated surface and left there for 10 minutes. The surface is then wiped with a soft brush and flushed with clean water.

Parts of equipment and bulky apparatus are decontaminated by immersion and cleaning in several stages. Immersion cleaning is done in vats. It provides sufficient time for the decontaminant to remain in contact with the surface being treated and permits diffusion from the cracks and pores of the surface. A bath temperature of about 60° accelerates the diffusion.

Multistage cleaning is done in stainless steel troughs with cocks for the solution. This method of decontamination (three stages of five minutes each) has proved to be more effective than the immersion method.

The following chemicals are used as decontaminating agents: (1) 0.5% solution of the tetrasodium salt of ethylenediamine tetraacetic acid (EDTA); (2) 0.5% solution of the trisodium salt of nitroacetic acid; (3) 0.5% solution of citric acid; (4) 0.25% solution of the tetrasodium salt of EDTA + a 0.25% solution of citric acid; (5) 5% solution of ammonia with a specific gravity of 0.88; (6) 0.5% solution of sodium bipyrophosphate (G. Wells, 1957). Sometimes the use of hydrochloric, sulfuric, nitric, and phosphoric acids are indicated to remove rust.

Work clothes contaminated by fission products and plutonium are effectively treated by washing them with a 0.5 to 1% solution of any salt of EDTA at a pH of 3 to 4.

Decontamination is total or partial depending on whether or not the radioactive substance has been removed from the surface of the contaminated object. Total decontamination requires a good deal of time, effort, money, and the availability of decontaminants.

Partial decontamination results in the removal of the radioactive substance up to permissible limits. It is usually done to provide access to a contaminated area or to contaminated objects, to remove radioactive contaminants from the clothes and shoes, equipment, technical facilities, and to eliminate the danger of people becoming contaminated by handling them. Partial decontamination in wartime serves to remove radioactive substances from the parts of weapons and combat materiel that the soldiers may touch during action.

Contaminated earth is removed by bulldozers, scrapers, graders, and other machines. Shearing off the upper layer and removing or covering it with uncontaminated earth results in decontaminating portions of an area. The same technique is used to make passageways through a contaminated region. Covering contaminated with uncontaminated soil not only reduces the activity of the gamma field, but also keeps radioactive dust particles from filling the air. A diagram showing how a passage is made through a contaminated area with subsequent diminution of radioactivity of contaminated soil is shown in Figure 55. Before making the passage, a trench is dug alongside where the contaminated soil is thrown (A. P. Glushko).

In the winter passages are made by cutting through and removing the snow, the thickness of the layer removed being 20 cm if the snow is loose and 10 cm if packed. The passages are generally one way and at least 25 m apart.

Slicing off and turning over the top layer of earth (about 20 cm) is done when the level of activity is high and there are no solid deposits. The method is useless for the epicenter of a blast where the soil is contaminated for comparatively great depths due to neutron radiation (induced activity).

An inhabited locality, roads, and bridges are decontaminated if the activity is above permissible limits. The first areas to be treated are such vital places as the passageways on the streets and squares for carrying out the injured, water and food supply lines.

An inhabited locality must be promptly decontaminated in order to ensure the safety of the people. First of all, the radioactive dust must be taken away or covered (with earth, building material, etc.), for it can penetrate the respiratory passages and digestive tract, settle on the skin or clothing. Thus, asphalted pavement, squares, and sidewalks must be decontaminated by sprinklers, harvesters, fire engines, vacuum cleaners, and other equipment available to the local authorities. Paved streets and squares must be sprinkled before they are swept. If there is no equipment for this purpose, measures must be improvised.

Open ground with good sorption qualities will absorb a substantial amount of radioactive substances when paved streets and squares, outer walls of buildings, etc., are washed. The accumulation of activity by the top layer of soil may reach considerable proportions. Under these circumstances decontamination is effected by shearing it off to a depth of 5 cm or covering it with at least 30 cm of uncontaminated soil.

The outer walls of concrete, brick, and stone buildings are handled by the "wet" method using sandblasts. Effectiveness varies with the depth to which the radioactive contaminants have penetrated. The paint on roofs is removed; sometimes the roofs have to be changed.

The task of the sanitation authorities is to trace the radioactive sewage produced during decontamination and to prevent open reservoirs from becoming polluted by radioactive substances.

Decontamination and construction of supply (evacuation) routes in combat zones is carried out by engineer units in accordance with the instructions of headquarters.

It is more difficult to decontaminate trenches, blindages, communication trenches, shelters, and dugouts owing to the impossibility of mechanizing the arduous work. Trenches are decontaminated by cutting away the top 3 to 5 cm of earth from the breastworks, front and rear slopes, and from the bottom of the ditches. The work proceeds strictly from top to bottom. The earth thus cut is taken at least 20 m away on the windward side. Under enemy fire this earth is placed in dead-end trenches and covered with sufficient clean earth to protect the personnel (A. P. Glushko).

Shelters and dugouts, like homes in inhabited localities, are usually decontaminated if radioactivity has exceeded safe limits. Intact walls, roofs, windows, and doors indicate that there are no radioactive substances inside. Special measures are taken to prevent contaminants from being carried in with shoes, clothing, equipment, and weapons -- decontamination of the contamination objects, replacing or leaving them outside.

Rooms are decontaminated systematically beginning with the ceiling, then the walls and the floor. Radioactive dust is removed with a brush, damp cloth, or vacuum cleaner. The furniture is wiped with damp rags or washed with soapy water (special detergents are available). The walls of dugouts and field-type shelters are sliced with a spade to a depth of 3 to 5 cm and the earth taken at least 20 m away. Dishes and plastic and rubber articles are washed in hot soapy water with soda. If the level of residual activity remains high, the procedure is repeated and the most contaminated objects removed and destroyed (by being buried in the ground or burned in special furnaces) if they are of little value (curtains, portiers, rugs, etc.). The ash left after the burning of radioactive materials, if it possesses marked activity, is buried 1.5 to 2 m in the ground. The burial site must be dry and elevated with a low ground-water level.

The decontamination of localities, residential and service areas, dugouts, and shelters must be carried out by trained personnel wearing gas masks, rubber gloves, protective overalls and stockings. When the work is finished, the vacuum cleanings and brushes are decontaminated; the rags with collected dust are buried in the ground. Decontamination procedures are executed rapidly to minimize the time of contact with the radioactive substances.

A serious problem in wartime is decontamination of weapons and combat materiel. Timely and sound decontamination is a major step in assuring the safety of troops operating in contaminated territory. Partial decontamination of weapons and materiel consists of removing radioactive dust from the weapons and combat vehicles. The surfaces are wiped with damp rags two or three times. In the winter the rags are dipped in such non-freezing liquids as kerosene, benzine, solar oil, dichlorethane, or alcohol. Weapons and parts covered with grease are decontaminated with the help of fat solvents (kerosene, benzene). After decontamination the parts are wiped and greased.

Large parts can be swept with a broom or cleaned with dry brushes -- tracks and turrets of tanks, wheels and chassis of automobiles, wings and fuselage of airplanes. The direction of the wind is taken into consideration when combat materiel is treated by the dry method. The zone of contamination thus created is fenced off, marked, and monitored.

The materials used for wiping decontaminated objects are placed in a previously prepared ditch when the work is over and the ditch itself is filled up with earth. In handling weapons and materiel in a contaminated area it is important to observe the rules of radiation safety: use protective clothing; do not sit or lie down on the ground; do not raise dust; do not burn radioactive material in bonfires or primitively constructed stoves.

Total decontamination is carried out at special processing points or in places prepared for this purpose. The work is done in an uncontaminated area by special teams. It is essential that the following order of the procedures be maintained: first monitoring, then decontamination if the level of activity is above permissible limits, and finally monitoring again. If the residual activity is still too high, the weapons and materiel are reprocessed.

Hand arms and heavy guns are totally decontaminated by washing off the radioactive substances with a powerful stream of water using portable apparatus, degassing machines, or gasoline filling stations. If these are unavailable, rags dipped in uncontaminated water and brushes are used. Grease is removed from parts by means of rags saturated with kerosene or benzine.

When the decontamination is over, the dirty part of the area is covered with earth (in the summer) and with snow (in the winter). The depth of earth or snow is determined by the level of radioactivity. After the work area is covered up, the level must not exceed permissible limits. After it is monitored, the area is fenced off and marked with the sign "Contaminated."

In wartime it is often necessary to decontaminate clothing and shoes. Radioactive substances usually cover the surface of clothing. However, liquid radioactive warfare contaminants may penetrate deeply into the pores of the material. Moreover, the physicochemical properties of the material may enable the radioactive elements to become absorbed by ions and larger groups.

Clothing and shoes prevent the dangerous contact of radioactive substances with the skin. However, even contaminated clothing may cause radiation injury to the skin and permit radioactive substances to enter the body. That is why clothing and shoes must be decontaminated as soon as possible. The outer garments are shaken, beaten, and vigorously brushed to get rid of radioactive dust. The shoes are wiped with rags, oakum, or other materials.

Total decontamination of clothing and shoes is carried out at special processing points by trained teams of men using technical teams and counters. If the activity remains excessive, the pieces are reprocessed. New uniforms and shoes are issued to the men if the contamination is unusually severe. Total decontamination is normally carried out in conjunction with sanitary processing at special points (Figure 56).

CHAPTER XII

AVIATION MEDICINE

[Note: Chapter XII is not translated here, because it was previously translated elsewhere.]

CHAPTER XIII

HYGIENIC PROTECTION OF ARMORED TROOPS

The tremendous importance of armored troops was fully demonstrated during World War II. Armored units include combat vehicles of all kinds -- tanks, self-propelled artillery mountings, armored cars, armored carriers, and special-purpose vehicles.

The modern tank is a cross-country combat vehicle with a powerful engine, protected with solid armor, and equipped with powerful guns. The principal components of a tank are the armored hull, engine, transmission mechanisms, running gear, and armament. The hull has four compartments: fighting, motor, transmission, and driving. The fighting compartment, which occupies the center of the tank, holds the tank commander, gunner, and loader. The driver sits in the driving compartment. In some types of tanks the radio gunner stays in the driving compartment. The fighting and driving compartments are interconnected (Figure 59). Modern tanks ordinarily have diesel engines operating on heavy grades of oil.

During World War II self-propelled artillery mountings appeared on the battlefield that differed from tanks in having more powerful armament, incomplete armor plating, and no revolving turrets. Now there are self-propelled artillery mountings with complete armor plating that are scarcely distinguishable from tanks.

The conditions under which the crews of tanks, self-propelled artillery mountings, and armored cars work and fight have a number of peculiarities that must be taken into account when planning the health protection of the men. The narrow space restricts movements, often cramps the position, and makes the static exertions of the body predominant, thus resulting in fatigue, despite the lack of much physical activity by the men.

Due to the comparatively high speed with which a modern tank travels, the conditions along the way change rapidly, especially when there are no roads, so that the driver must react swiftly and accurately. He must observe the road and the battlefield in addition to maintaining continuous communication with the unit leader and his fellow crewmen. The complex equipment used for observation and communication requires skillful handling, constant training, and alertness.

The task of tankmen is made more difficult by the intensity of the noise. As the tank moves, especially over roadless terrain, the men are continuously jerked about and shaken so that they have to use a good deal of muscular energy to stay in position. It is very hard under these conditions to observe the road and battlefield through the vision slits and optical devices as well as to fire.

Carbon monoxide in tanks may reach toxic proportions mainly during heavy firing. The air is also polluted by exhaust gases containing the products of incomplete combustion of the fuel.

Tank maintenance inevitably results in soiling the clothes and skin of the men by oils and greases, causing irritation and dermatitis. Folliculitis due to mineral oils is a typical skin disease of tankers.

The microclimate in a tank changes considerably depending on the climatic conditions of the locality and weather. During the summer in the southern regions of the USSR the armor heats up to 65 or 70°, which impairs thermoregulation and creates a danger of overheating. During a hot summer, heat emission by radiation and conduction is virtually impossible; heat is emitted largely through the evaporation of sweat from the body. Profuse sweating disturbs the water and salt exchange and makes the men more thirsty.

The environment has the greatest effect in the summer owing to the consequences of overheating and to the comparatively limited possibilities of combatting the influence of high temperatures on the sense of well-being and working capacity of the men.

The cumulative effect of meteorological conditions (temperature, humidity and rate of air movement, infrared radiation) is to increase considerably the stress on the thermoregulatory apparatus. On leaving the tank in the summer the men sometimes feel fatigue, heaviness in the head, have a ringing and noise in the ears, headache, weakness in the arms and legs. The intensity of these subjective reactions varies with the weather, design of the machine, and degree of training.

During the winter the weather has an opposite effect: sudden cooling of the armor greatly intensifies the emission of heat by radiation. Touching cold metal surfaces sometimes causes "contact" frostbite. However, man is better able to adapt to the cold. His resistance can be substantially increased with the help of intelligently selected clothing and systematic training (toughening). The experience gained during World War II has demonstrated that frostbite can be successfully controlled.

Tank Vibration

The hull vibrates as the tank moves along due to unevenness of the ground. The added time it takes to aim decreases the accuracy and maximum rate of fire. Every vibration is characterized by a certain amplitude, periodicity, acceleration, and force. The amplitude of vertical vibrations depends on the unevenness of the road and ground. With moderate unevenness the line of aim shifts parallel to itself up and down by about 100 to 150 mm. The frequency of longitudinal angular vibrations ranges from 40 to 200 a minute, but usually does not exceed 60 vibrations. The frequency of vertical vibrations ranges from 60 to 250 a minute for various tanks (A. Antonov, B. Artamonov, D. Korobkov and Ye. Magidovich).

The complexity of tank vibrations is shown by recordings. However, two main types may be distinguished: periodic and jerky. In the former a moving body shifts to this side or that and returns to

its original position at regular intervals of time. In the latter there is no regularity of vibrations. As the tank travels, there are jerky vibrations varying with the ruggedness of the terrain.

The effect of jerks on the human organism is determined by their amplitude and duration. The greater the amplitude and shorter the time, the stronger the effect of the jerks. Continuous jerking of low amplitude has relatively little effect.

Constant, irregular jerking can tire a man by compelling him to use his muscles in order to retain his balance. The number and intensity of muscular contractions is quite obviously related to the number of jerks and degree of acceleration. The sharper the jerks and the more there are of them per unit of time, the more vigorously and more frequently must the muscles contract to maintain the equilibrium of the body. Equal, rhythmic vibrations enable the body to adjust with less expenditure of energy.

Automatic devices for aimed fire while moving largely eliminate the effect of vibration on accuracy.

Vibration greatly complicates the crew's working conditions and hinders the conduct of aimed fire. It interferes with observation of the battlefield and use of optical instruments.

The use of special devices (equalizers) does a good deal to minimize the effect of vibration on the human organism.

The Noise Factor

The noise of the engine and tracks in a modern tank creates a background of noise that makes it difficult for members of the crew to talk to one another. Nevertheless the tank commander and driver must be able to get their bearings quickly and detect by ear any defects in the operation of the complex mechanisms. Consequently, tankmen must listen attentively and be able to differentiate noises.

Operation of the engine and movement of the tracks create a background of sound which is intensified by the noise of the exhaust and other things. Noise in tanks is of twofold significance: (1) it complicates the task of communicating by voice or telephone; (2) when prolonged, it is harmful to the health by causing fatigue. Studies of industrial noise have shown that noise louder than 60 db is harmful to man.

The intensity of noise made by a tank is related to the mode of operation of the engine and rate of speed. According to P. Gron'yo and A. Zhiber, the noise inside a tank standing still attains 93 db at 1,200 rpm, rising to 112 db when the rpm is increased to 2,700. With the tank in motion the volume rises to 97 db at a speed of 10 km/hr, 110 db at 20 km/hr, and 114 db at 50 km/hr.

The volume of sound attains 100 db 3 m from the tracks when the vehicle is moving at a speed of 10 km/hr and 120 db when the speed is increased to 50 km/hr. It remains at the 114 to 119 db level 3 m from the exhaust.

A rough idea of the intensity of noise can be obtained from the scale of speech of differing loudness. Ordinary speech is perceived at a noise level of 50 db. Conversation with raised voice is possible when the level is 70 db. At 100 db human speech cannot be perceived at all.

The spectral composition of tank noise is shown in Figure 60 (G. Altukhov). It is evident that frequencies of the order of 200 to 800 cycles a second predominate in the spectrum. It should also be borne in mind that tank crews are subjected to the low noise of the engine, comparatively loud noise of the tracks, and vibration of the hull.

Noise can be attenuated or eliminated by: (1) taking steps to weaken or deaden the major source of noise; (2) using soundproof partitions; (3) protecting the ears.

The personnel can be protected by using insulating material in the sides of the tank and sound-absorbing flooring. Improved mufflers, shock absorbers, and noiseless gear drives, etc., are very important.

Individual protection is afforded by earplugs -- soft antiphones of cotton, sponge, rubber tubes and corks; pliable -- wax or paraffin combined with cotton wool; rigid -- in the form of balls, olives and funnels with a diaphragm.

There is the disagreeable sensation of a foreign body in the external auditory canal when rigid antiphones in the form of hard rubber plugs are used. It sometimes becomes painful when an attempt is made to open the mouth and it remains for some time after the plugs are removed.

The soft plugs of N. Alekseyev (made from rubber fingerstalls) are the most successful devices of this type. The author has suggested as filler loose material like glucose in powder and anhydrous sodium sulfate, which are very convenient to use and have good sound-absorbing properties. The Alekseyev plugs are made from two rubber fingerstalls and 0.4 to 0.6 g of glucose or anhydrous sodium sulfate. Tests have shown them to be superior to other devices in that: (1) the commander's voice is audible within 30 m; (2) there are no unpleasant sensations in the ears after firing; (3) after three minutes artillerymen are no longer conscious of wearing them; (4) there are no unpleasant sensations in the external auditory canal after three hours of use. It is important to note the favorable opinion expressed by antiaircraft artillery gun crews whose working conditions are unusually severe (intensity of fire, deafening effect).

The report of the guns reaches the organ of Corti not only through the external auditory canal (which can be blocked off and even insulated from the air), but also through the bones of the skull, skin, and muscular tissue. Hence, bandage-type devices provide the most effective protection. In practice, however, they are not worn because they are too clumsy and interfere with the headgear, although they do a good job of keeping out noise and do not irritate the external auditory canal.

Successful attempts have been recently made to combine an anti-noise device with a tank helmet. A headphone and laryngophone are mounted as a unit with the helmet. The laryngophone (an instrument that perceives the vibration of laryngeal tissues) enables the crewmen to talk with one another. The use of insulating pads protects the ears and headphones from the noise.

Helmets intended to protect the ears from loud noises must cover the helix, porous part of the temporal bone and portion of the skull in back of the lower jaw. This prevents sound transmission through the air and disrupts bone conductivity. The so-called impenetrable ring of a tank helmet must exert considerable pressure on the underlying tissues (about 5 kg over the entire area of the rim). It is therefore difficult to wear the helmet constantly. A good helmet weakens noise by 15 db when the frequency is 400 cycles per second, 20 db - 800 cycles, 25 db - 1,600 cycles, over 30 db - 3,200 cycles and higher. A helmet combined with antinoise device can increase protection to 25 to 27 db when the frequency ranges from 125 to 500 cycles, 30 to 35 db - 500 to 2,000 cycles, and 45 db - from 5,000 cycles on (P. Gron'yo and A. Zhiber).

Observation Conditions

During World War I the principal means of making observations from a tank was to look through the vision slit, which provided a limited field of view and little protection for the observer. About 50% of the wounds suffered by tankmen were in the eyes and face. The size of the slit was determined by the smallest caliber of the anti-tank guns, thickness of the armor, and space between the slit and eyes of the observer.

Modern tanks have different devices for observing the battlefield. The simplest is a mirror periscope consisting of two parallel mirrors placed at an angle of 45° to the horizon. In the outside part of the device the head is protected by an armored cupola. The periscope permits a 60 to 90° field of view to be observed in safety.

The two-way periscope is more complex, permitting observations to be made forward and backward (Figure 61). The outside part is enclosed in an armored cupola to prevent damage by enemy fire.

The tank commander makes observations of the terrain from the turret through vision slits enclosed in glass or through a mirror periscope. If there is no turret, all-around vision is achieved through a two-way observation periscope. Distant targets are observed with the help of binoculars. During a battle the gun commander and machinegunner conduct observations through a sight that shifts with the gun.

The difficulties of observing the road and battlefield while the tank is moving makes stern demands on the tankman's eyes. Before a man is assigned to a tank unit his eyesight must be carefully checked

along with his ability to distinguish objects quickly. Too much importance, however, must not be attached to the opthmalogical examination because a man can be systematically trained to make effective use of instruments for observation purposes. The physician of an armored unit is required to help the officers teach the personnel the correct way to handle the devices.

Illumination in Tanks

The amount of natural light in combat vehicles varies with the time of year and day, position of the sun on the horizon, and degree of cloudiness. There are abrupt shifts from bright light to shade and back. Natural light inside a tank decreases markedly when the hatches are closed.

As a result of the eyes' shifting from well lit to poorly lit surfaces and back, fatigue and loss of acuity of vision are inevitable. To work in modern fast moving vehicles under constantly changing conditions requires rapid perception of all the changes and accurate reaction to them.

The importance of normal light and color sensitivity on the part of drivers makes it essential for the doctors of armored units to pay special attention to the condition of their eyes. Men suffering from diseases of the retina and choroid must be promptly removed. With hemeralopia night departures and exercises with materiel at twilight or at dawn are contraindicated. Twilight vision must be tested before a man is sent to tank school.

Traveling at night or in a haze makes great demands on the sight of drivers who have to get their bearings from faintly illuminated objects. The ability to distinguish details of objects is reduced at night and spatial ideas become altered. Things seem closer and larger. In the case of precision firing it is noted that the upper sections of the targets are hit. Dim objects seem to move more rapidly than they actually do.

The need to read measuring instruments and maps compels the tank driver and commander frequently to turn their eyes from darkness to light and back. Rapid shifting of the eyes from dim to bright objects profoundly disturbs adaptation. A. V. Lebedinskiy has shown experimentally that reading an operations document for half a minute by the light of a flashlight reduces the sensitivity of eyes adjusted to the dark by 80%. Moreover, the high degree of sensitivity attained during 45 minutes in the dark reverted in half a minute to the level of adaptation reached after 15 minutes. This shows the importance of efficient lighting of combat vehicles if the eyes are to function normally.

The use of infrared technology in modern war machines makes possible a radical solution of the problem of observing the battlefield and delivering fire efficiently. Employment of computers in tanks also contributes to the accuracy of fire.

Artificial lighting, which is tremendously important during night actions, must provide for: (1) easy reading of the instruments and maps and keeping of records; (2) maximum retention of twilight adaptation needed to observe the road and battlefield; (3) maximum uniformity; (4) possibility of adjusting the illumination to the vision of the driver; (5) possibility of using light filters to include color and camouflage lighting.

The Dust Factor

As a tank moves over dirt roads it stirs up a tremendous amount of dust that penetrates through the hatch and vision slits into the interior of the vehicle. The effect of dust on the body varies with the size, structure, chemical composition, and quantity of the particles. Road dust, which contains 95% silicon oxide and about 3% organic substances, irritates the mucous membrane of the eyes and respiratory tract, soils the clothing and skin. In a war it is also possible for dust to be mingled with poison gas, radioactive substances, and pathogenic microorganisms.

Effective means of combatting road dust include the raising of pressure inside the tank, covering the vision slits with unbreakable glass, and wearing of goggles.

Protective spectacles for tankmen must: (1) be made of unbreakable glass; (2) not narrow the field of view too much; (3) dependably protect the eyes from dust, snow, rain, and wind; (4) not fog up in the winter. If necessary, they should be capable of undergoing disinfection, degasification, or decontamination.

When a tank passes through a region contaminated by poison gas or radioactive substances, there is a danger that contaminated dust may penetrate the body. If this danger is determined to exist by radio-prospecting, steps are taken to close all the slits and, by order of the tank commander, all members of the crew put on gas masks. After this is done, the armor, tracks, weapons, and inside equipment of the tank are decontaminated in accordance with special instructions.

Pollution of the Air in Tanks by Gases

The air inside tanks may contain carbon monoxide, nitric oxide (during firing), carbon dioxide, saturated and aromatic hydrocarbons. When the outside temperature is low, the hydrocarbons condense and do not get inside. The gaseous products constituting the uncondensed portion of exhaust gases may under certain conditions enter the tanks and irritate the upper respiratory passages of the men.

One must be particularly careful about carbon monoxide because of its high toxicity; it is always present in powder gases. The exhaust gases of modern tanks, which run on heavy fuels (gas oil, solar oil), contain very little carbon monoxide. Before World War II when tanks

were fueled by gasoline, the exhaust gases contained carbon monoxide and inside the tank they threatened the crew with CO poisoning. The threat of acute and chronic poisonings comes from the powder gases entering the tank.

The danger of CO poisoning arises during intense firing of machine guns and cannon when powder gases are discharged from the bore of the cannon as a result of the sucking action of the breechblock and from the breech casing of machine guns. The empty shell cases dropping inside the tank are another source of poisoning. A substantial amount of CO may penetrate to all the compartments during intense machine gun and artillery fire.

The combustion products of gunpowder include nitric oxide in addition to carbon monoxide. Although nitric acid is about 10 times more poisonous than CO, the calculations of air exchange must be based on the accumulation of carbon monoxide, which amounts to 33% of all the combustion products of gun powder (20 times the content of nitric oxide).

By knowing the conditions under which CO and other toxic substances accumulate a tank crew can take the necessary protective steps in time, the most important being active ventilation of the turret and driving compartment during firing. The personnel must be taught the rules for self- and mutual help in case of CO poisoning. They must be acquainted with prophylactic measures and be able to use them in combat.

The combined effect of overheating and toxic gases (carbon monoxide, nitric oxide) is particularly dangerous. Experimental data indicate that the toxic effect of carbon monoxide, exhaust gases, and nitric oxide is intensified by high temperatures and overheating. Therefore, when the air temperature in enclosed spaces is very high, the maximum permissible concentration of toxic substances must be lowered.

Chronic Carbon Monoxide Poisoning

The possibility of chronic carbon monoxide poisoning has now been shown by experiments on animals and by clinical observation. The symptoms of chronic poisoning include: malaise, persistent headaches, sensation of pressure in the head, insomnia or drowsiness, memory lapses, neuralgic pains throughout the body, dizziness (chiefly in the morning and when looking up), heightened excitability of the vestibular apparatus, tremor of the extremities and twitching of the facial muscles, paresthesia, dyspeptic disorders (lack of appetite, nausea, vomiting, diarrhea), pallor, grayish hue of the face, malnutrition (I. G. Fridlyand).

Increases in the hemoglobin content and number of erythrocytes are among the objective symptoms. Erythropoiesis and polycythemia become intensified mainly during the initial phase of chronic intoxication and with good functional capacity of the hematopoietic system when carbon

monoxide acts as a stimulant. At later stages when the hematopoietic function weakens anemia, usually of the hyperchromatic type, develops.

Of indisputable diagnostic value is the presence of carboxyhemoglobin in the blood (even as little as 2 or 3%). Blood tests in acute and chronic poisonings have shown that whereas in the former carbon monoxide disappears fairly quickly, in the latter it remains a long time in the blood.

Besides carbon monoxide, exhaust gases contain admixtures — still insufficiently studied — that are not without effect on the organism. These include the fumes of acrolein or allyl aldehyde, which irritates the mucous membranes of the eyes and air passages in small concentrations and has a narcotic effect in large quantities. Air containing 0.02 mg/l of acrolein causes tearing and coughing. Greater concentrations cause inflammation of the air passages.

Acrolein fumes are formed by the decomposition of lubricants and heavy fuel oils due to heat. In the air of tanks with gasoline engines it has been possible to find only traces of acrolein, which do not cause tearing or other eye disorders. When the army shifted to the use of heavy fuel for tanks, the acrolein content of exhaust gases rose sharply and the danger of its entering the vehicle grew considerably. The maximum permissible concentration of acrolein in the air is 0.002 mg/l.

Gasoline fumes may also produce a toxic effect when they penetrate the air passages while the vehicles are being fueled. Fumes arise from leaks, engine surfaces, clothes, etc., wet by gasoline.

Gasoline entering the organism through the air passages and skin causes poisoning that shows up in the form of intoxication accompanied by excitation, loquacity, hand tremors, dizziness, and weakness. The symptoms of chronic poisoning by gasoline fumes include depression, headaches, nystagmus, loss of appetite, and restless sleep. Anemia may also develop due to impaired hematopoiesis. A person can tolerate for brief periods of time a concentration of fumes of about 10 mg/l. The maximum permissible concentration in the air may, according to law, be no higher than 0.3 mg/l.

Gasoline can cause dermatitis by dissolving skin fat. Dried out by the fuel, the superficial epidermal layer of the skin becomes covered with cracks that promote the development of furunculosis, ulcers, and eczema.

Preventive measures include removal of the fumes by ventilation at the place where they are produced, prohibition against using the fluid to wash the hands and parts of the engine, and regular changes of work clothes. The appearance of signs of anemia must be regarded as a warning requiring prompt prophylactic and therapeutic measures.

Ventilation of Tanks

An analysis of air pollution in tanks shows the main cause to be insufficient fresh air. Fresh air can be supplied by artificial ventilation, thereby completely doing away with the danger of chronic poisoning by toxic admixtures.

Due to the rapidity with which carbon dioxide accumulates in the fighting compartment of a tank, it is essential to calculate the correct rate of air exchange and to determine the capacity of the fans. For example, if the maximum permissible concentration of CO_2 in the air of a combat vehicle is 3%, the amount of ventilation air an hour per man can be determined from the following formula:

$$L = \frac{k}{p-a},$$

where L is the volume of air; k is the amount of CO_2 exhaled by one person in an hour; p is the maximum permissible concentration of CO_2 in a combat vehicle; a is the CO_2 content of the atmosphere. After substituting the appropriate numbers, the formula will look like this:

$$L = \frac{25.0}{3.0 - 0.4} = 9.6\ m^3.$$

This means that every member of the crew needs about 10 m^3 of fresh air an hour. Assuming that each man requires an average of about 1 m^3 of air space, 10 times the volume of air (especially in the summer) has to be supplied to meet these conditions. This amount is unacceptable for living quarters due to the considerable cooling effect, but it is quite all right for combat vehicles.

The problem of ventilating tanks is closely related to protection of the personnel against poison gas and radioactive substances. Accordingly, filter-type apparatus is used to supply air freed from poison gas, radioactive and bacterial aerosols and to create the required air pressure.

The fan design must take into account the need of creating air pressure inside the tank. The output and efficiency of the apparatus will depend on how airtight the vehicle is. It is difficult to obtain the required amount of air pressure if the tank is not sufficiently airtight.

Skin Care

The conditions under which the men work in tank parks and shops have a number of features that tend to affect the skin unfavorably: (1) the physical exertion involved in repairing and maintaining the machines which cause excessive perspiration and cooling of the damp portions of the skin; (2) irritation of the skin by sweaty clothes clinging to the body; (3) the use of clothing impermeable to air which

[illegible] difficult for the skin to perspire; ([illegible]) dirtying of the skin [illegible], oil, and dust; (5) fine injuries from working on a machine; ([illegible]) [illegible] of cold during repair work on the road.

Chemical irritants (oils, etc.) are potent in that they block up the [illegible] and fat glands and dry out the skin. That is why those working in shops and parks must take a shower or wash up with warm water at the end of the day.

At the same time the working conditions in the vehicles and [illegible] must be rationalized so as to eliminate the factors that make [illegible], heating and cooling of the skin. The use of gasoline for cleaning the hands and clothing must be absolutely forbidden. The men must be taught that soap and hot water do a quicker and better job than gasoline, which dries out and defats the skin.

Summer work clothes should be made from light, loosely-fitting but sturdy cloth. They get soiled quickly and must be laundered regularly. The intervals at which they should be changed vary with the degree of soiling, but laundering at least once a month is mandatory.

Special protection must be afforded the head due to the speed with which tanks can travel and the constant vibration. A helmet with elastic inner band is helpful in absorbing jolts.

Since the feet are actively used in driving it is important that the shoes be properly designed. They must be light, elastic, and non-constricting while permitting the soles to remain highly sensitive to the pedals. The shoes must protect the feet against cold and dampness in the winter and against overheating in the summer.

The experience gained during World War II has shown that the most efficient type of uniform for tankmen is a jacket narrow in the waist plus long trousers with cuffs turned down. This outfit enables a man to get in or out of the vehicle quickly and it does not impede his movements in any way. The shoes should have no projections or iron heel taps, which make it difficult to walk over armor. It was also learned that the clothing should be impregnated with fire-resistant substances. The value of this treatment showed up even more clearly during the Korean hostilities when napalm was used for the first time.

It is essential that the clothing be properly cleaned, for oil-stained garments retain dirt on the surface and in the pores of the material which irritates the skin and contributes to the development of pyodermatitis, folliculitis, etc. The work clothes should be soaked in lye and then scoured.

Physical Training

Physical training plays an important part in preparing tankmen for combat. It is the basis for perfecting the necessary skills and the best way of improving the health. Physical training must permeate the entire system of instruction of armored troops and become inseparable from their study routine and living conditions.

Unlike the situation prevailing in the infantry where the very process of combat training includes many elements of physical exertion, work in tanks is predominantly a matter of static tension. Tank troops are exposed, moreover, to a variety of factors the negative influence of which can be avoided by a properly planned program of physical conditioning. Tankmen have to perform duties requiring special skills which can be readily acquired through general physical training reinforced by special exercises.

The training program for tank troops is based on exercises designed to: (1) increase muscular strength, dexterity, and the ability to judge movements accurately; (2) increase the speed and precision of motor reactions; (3) develop skill in making complex, assymetrical movements; (4) teach the men how to work on an engine and how to take care of it; (5) develop habits that improve the health and overcome the exhausting effect of static exertions.

Special attention is focussed on toughening the men by exposure to water and air, which also is the best means of preventing skin and respiratory diseases. The toughening process starts from the moment the men reach their units and is carried on systematically until their period of service is over. Exercises simulating conditions in the tank are useful, e.g., jumping, leaping into and out of the vehicle, carrying heavy loads, "wounded" men, etc. Exercise periods during marches and in the garage are very valuable. Their purpose is to overcome venous congestion, place a dynamic load on the muscles of the upper extremities, shoulder girdle and small of the back, and increase lung ventilation. The exercises should be few in number and simple to do. Sometimes rapid walking combined with deep breathing is very refreshing.

The training program lays stress on strength exercises involving shells and lifting weights. Cross-country races take the place of marchdashes for tankmen. Authorized equipment is used in connection with the obstacle-training course. Mass sports activities include heavy athletics, boxing, wrestling, and gymnastics.

Repair Shops

Tank repair shops must be equipped with fans to draw out exhaust gases. It is absolutely forbidden to start motors in closed places unless there are fans or gas vents. If there are none, the motors must be tuned up and tested out in the open.

It is particularly dangerous for mechanics to wash their hands with gasoline and to clean and polish motor parts. In the first case there is the danger of gasoline poisoning; in the second there is the danger of lead poisoning if the motor operates on ethylated (lead) gasoline. The so-called "scale" contains a great deal of lead, which must not be removed by the dry method. Motors are to be repaired only after the scale is removed in baths with kerosene or a special mixture. It is absolutely forbidden to use lead gasoline to wash motor parts.

For those working in an electroplating shop the greatest danger comes from inhaling fine droplets of chromic anhydride solution used in chrome plating. Occupational rhinitis, pharyngitis, and laryngitis caused by poisonous chromium compounds can be prevented by equipping the galvanic baths with reliable local ventilation devices. Before starting to work the men should apply a film of cream or vaseline to the mucous membrane of the nose and remove the ointment or vaseline with some cotton at the end of the day. Ointments are recommended to protect the hands against acids and alkalis, which cause eczema and dermatitis.

The doctors should carefully watch the men engaged in charging batteries, for they are exposed to the fumes of sulfuric acid. They must be supplied with special clothing, rubber shoes, gloves, and protective goggles.

Medical care of repair shop workers is provided by doctors and feldshers of the armored troops. In addition to the initial examination, they make periodic check-ups.

Feldshers under the direction of doctors are responsible for inspecting the sanitary condition of the shops, effectiveness of ventilation, supplying the men with special clothing, kerosene, soap, warm water for washing the hands, and ointment for the nose and hands, etc. Daily examinations serve to guard against the development of dermatitis. If necessary, the skin of the hands can be treated with a ointment consisting of 3 g of gelatin, 7 g of starch, 40 g of glycerin, 25 g of Burow's solution, and 7.5 g of water.

Lead (Ethyl) Fluid

Lead (ethyl) fluid containing more than 50% tetraethyl lead (T.E.L.) is added to the fuel of internal combustion engines as an anti-knock ingredient. Lead or ethylated gasoline is obtained by adding to it 2 to 3 ml/l of lead fluid. The resultant gasoline is pink. Tetraethyl lead, from which the lead fluid is prepared, is an oily, colorless fluid with an apple-like odor, readily soluble in gasoline, benzene, or kerosene. It is highly poisonous. Lead fluid is also toxic, but only half as much as T.E.L.

Lead (ethyl) fluid can cause poisoning after entering the body through the skin, air passages, or digestive tract. In the last case the symptoms of poisoning show up very quickly; poisoning through the skin and lungs develops after a few hours, sometimes days.

The chief symptoms of lead poisoning are insomnia and nightmares, heightened irritability, loss of memory, headaches, and general weakness. Objective symptoms include bradycardia (pulse about 40 beats a minute), low body temperature (about 35°), hypotonia (maximum blood pressure 75 to 80 mm), persistent dermographia, and finger tremors while the hands are outstretched. Lead is found in the urine, blood, and feces; hematoporphyrin is excreted with the urine.

Special instructions on prophylactic measures have been prepared for those required to work with lead fluid. The specially selected personnel are kept under constant medical observation, and their blood, urine, and feces are analyzed periodically in the laboratory. They are immediately relieved of their duties if they exhibit the slightest signs of poisoning. Lead fluid, it should be borne in mind, is cumulative in effect and is eliminated very slowly from the body.

The fluid must be handled in the open or in well ventilated rooms. The content of T.E.L. fumes in the air of work areas must not exceed 0.00001 mg/l. Persons working with T.E.L. and lead fluid must wear special overalls, gas masks, rubber gloves and boots.

If any lead fluid strikes the skin, the affected portions must be promptly washed with kerosene or gasoline (not ethylated) and then carefully cleaned with warm water and soap. If the fluid gets on to the clothing, the latter should be immediately taken off and the skin washed with kerosene (or gasoline) and then with warm water and soap. The clothing is degassed.

If any lead fluid is accidentally swallowed, treatment includes gastric lavage, administration of emetics, drinking of milk, protein products, and magnesium sulfate to convert the lead into insoluble compounds. The eyes are washed with physiological solution and warm water.

Doctors responsible for observing the personnel at mixing points and stations are required to ask them daily how they feel, make weekly check-ups, immediately examine sick people and relieve from work all those exhibiting any symptoms of poisoning, periodically analyze the blood, urine, and feces for lead, investigate compliance with the prophylactic measures specified in the instructions (use of overalls, gas masks, rubber gloves and boots, kerosene, warm water and soap), and carry out educational activities.

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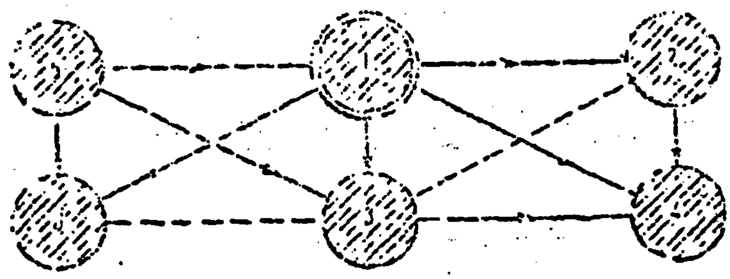

——— Main functional connection

- - - - - Secondary

Figure 1. Functional connection between the zones of a large military range

1 - training-drill zone; 2 - combat material and tractor zone;
3 - housekeeping zone; 4 - storage zone; 5 - living zone;
6 - clubhouse and sports zone.

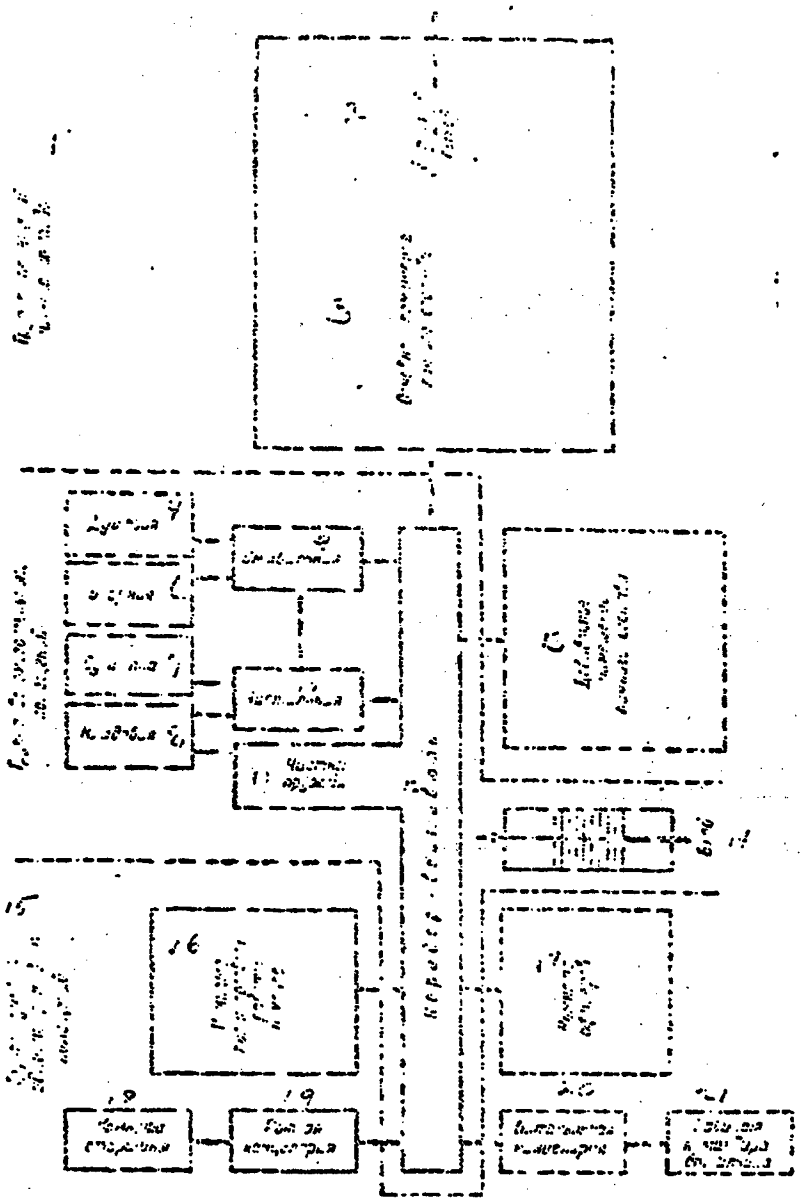

Figure 6. Functional connection between barracks rooms (according to L. S. Karperovich). [Legend on following page]

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Figure 5. Exposure of buildings to the compass points in zones III and IV (according to L. [illegible] Velikovskiy)

a - latitudinal; b - permissible deviation

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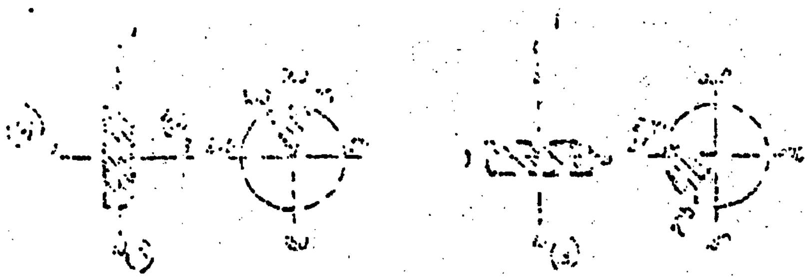

Figure 3. [illegible] of windows of living quarters in climatic zones I, II, III, and IV in the USSR (according to L. B. Velikovskiy).

1 - I; 2 - F; 3 - S; 4 - [illegible]

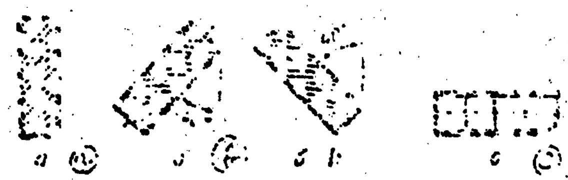

Figure 4. [illegible] of buildings to the compass points in climatic zones I and II (according to L. B. Velikovskiy).

a - meridional; b - deviation from the meridional direction; c - possible layout for rooms with light on both sides

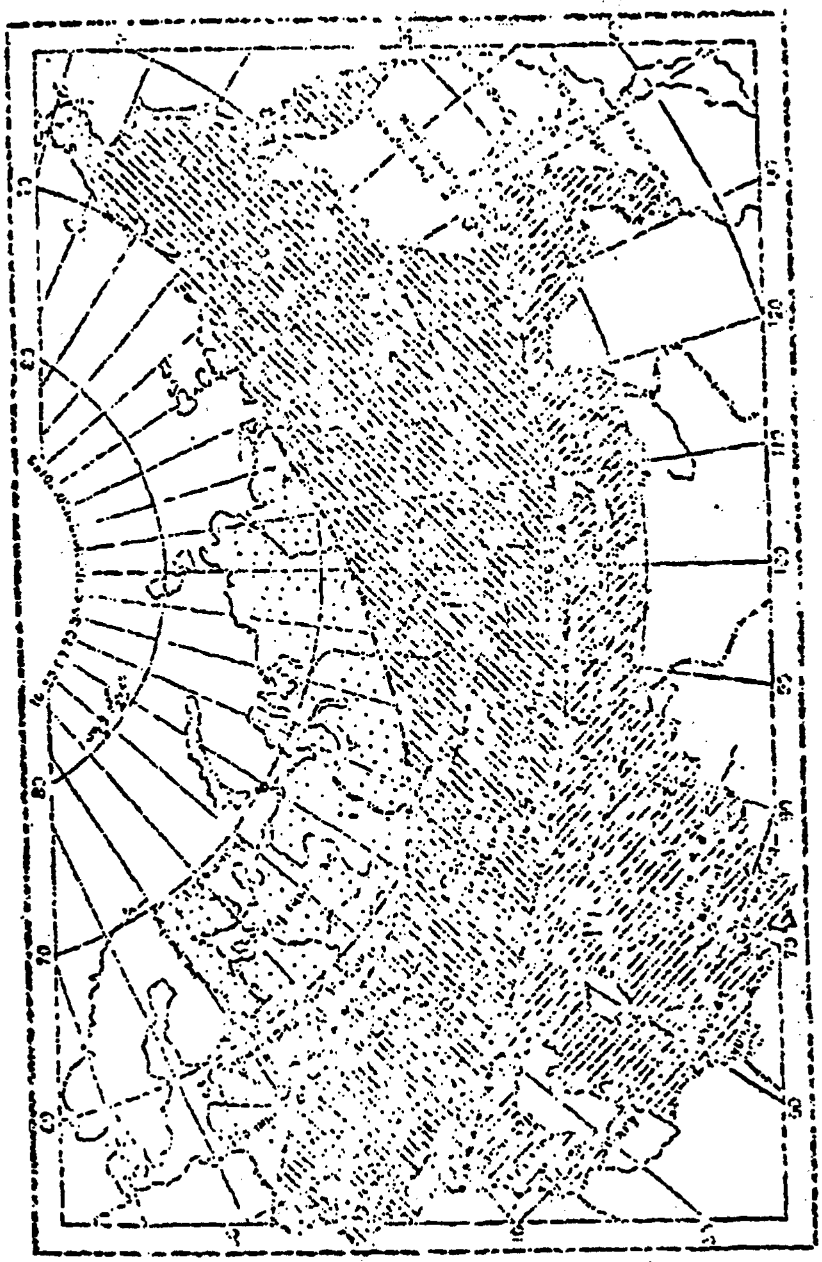

Figure 2. Light-climatic zones of the USSR.

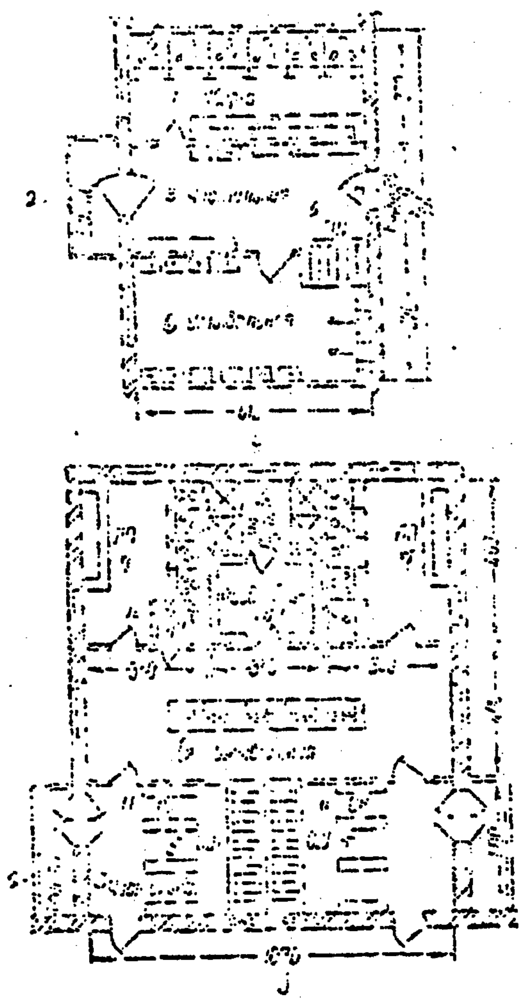

Figure 7. Sanitary units in a barracks (according to L. E. Vaitkovskiy): a - sanitary unit for 75 to 90 men; b - sanitary unit for 115 to 135 men.

Legend:

1 - toilet; 2 - lavatory; 3 - cleaning room; 4 - corridor; 5 - drying closet; 6 - Inventory; 7 - trough urinal; 8 - shower room; 9 - undressing room; 10 - Officers' toilet; 11 - bench for cleaning shoes.

NOT REPRODUCIBLE

Figure 6, Legend:

1 - Group of rooms for personnel
2 - Emergency exit
3 - [illegible] of the personnel
4 - [illegible] room
5 - Group of auxiliary rooms
6 - [illegible]
7 - Drying room
8 - [illegible]
9 - Lavatory
10 - Cleaning room
11 - Cleaning of weapons
12 - Corridor-entrance hall
13 - Additional space for personnel
14 - [illegible]
15 - Group of training and administrative rooms
16 - Political study room and classroom
17 - Officers' room
18 - Master sergeant's room
19 - Company orderly room
20 - Battalion orderly room
21 - Battalion commander's office

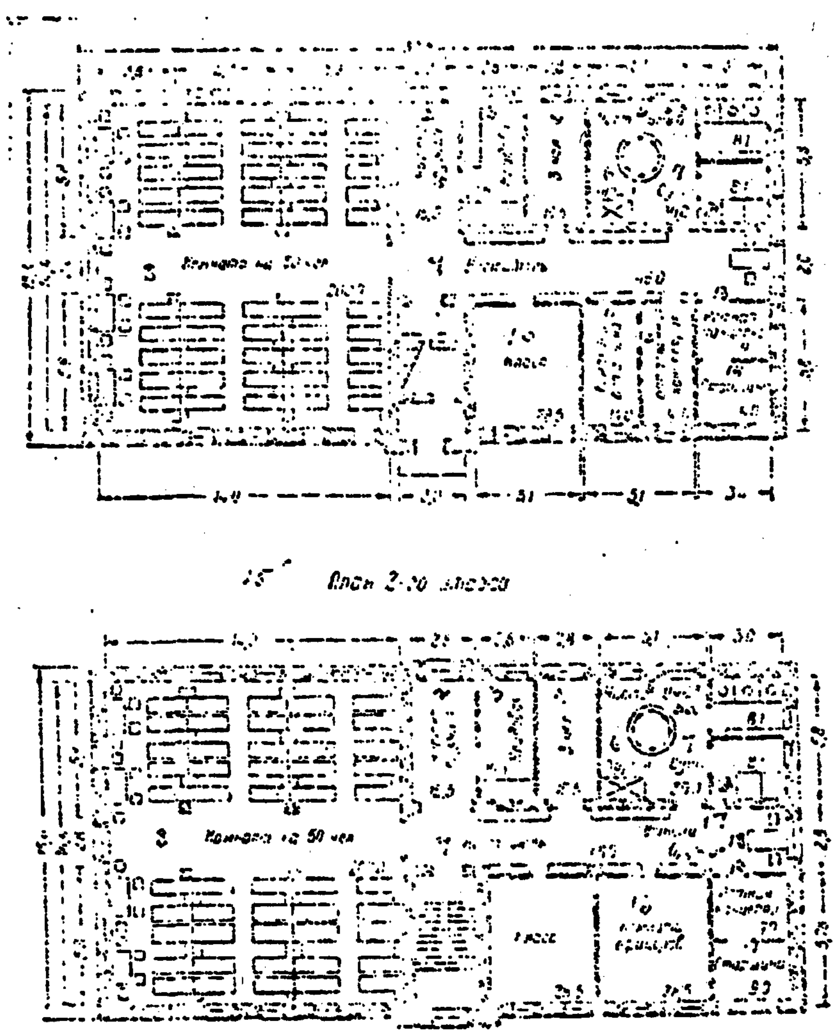

Figure 8. Barracks for 106 to 122 men (plan of N. S. Kasperovich, 1951). [Legend on following page]

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[illegible] Legend:

1 - Layout of first floor
2 - [illegible] weapons
3 - Storeroom
4 - [illegible]
5 - Cleaning room
5a - Lavatory
6 - [illegible] room
7 - Drying room
8 - [illegible]
9 - Hallway
10 - Classroom
11 - [illegible]
12 - Battalion orderly room
13 - Company orderly room
14 - [illegible]
15 - Layout of second floor
16 - Officers' area
17 - [illegible]
18 - [illegible]

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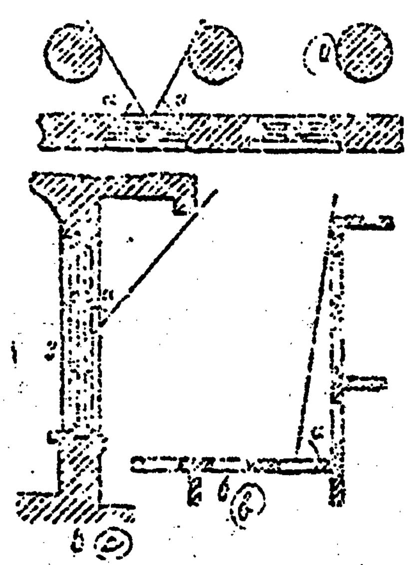

Figure 9. Determination of angle α of shading of window: a - columns; window near building angle; c - overhangs and loggias; d - middle of window; α - angle of shading (according to S. I. Vetoshkin).

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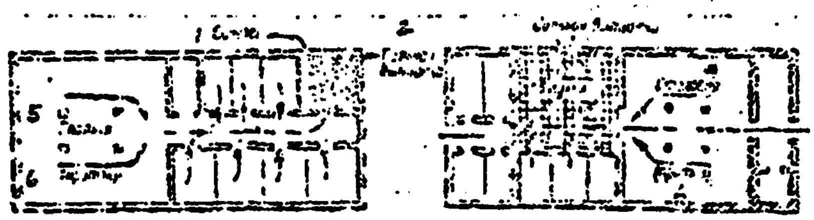

Figure 10. Direction of air currents in a barracks (left) and in a kitchen-mess room (right) (according to L. E. Velikovskiy)

Legend:
1 - Sanitary unit; 2 - strong exhaust; 3 - kitchen; 4 - mess room; 5 - sleeping quarters; 6 - air supply.

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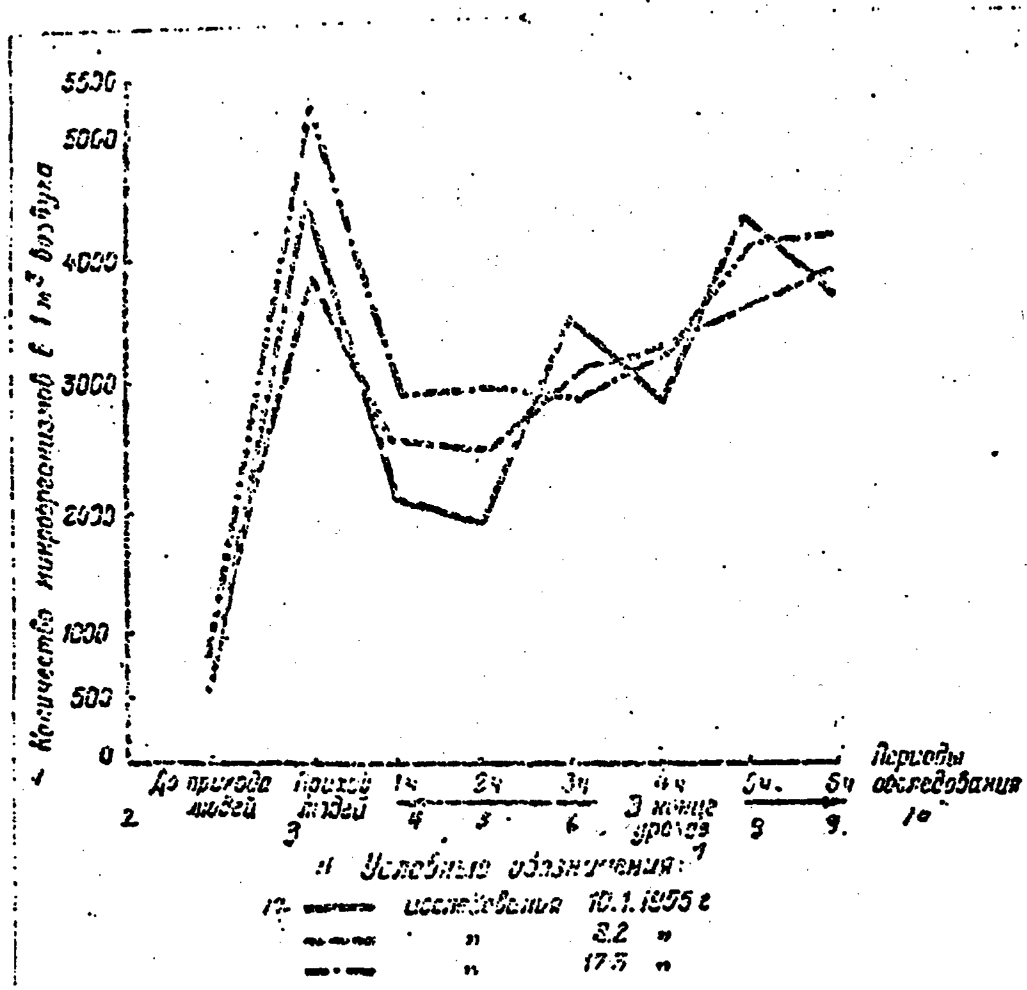

Figure 11. Bacterial contamination of the air in a classroom.
[Legend on following page]

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Figure [illegible], Legend:

1 = [illegible] of microorganisms in 1 m^3 of air
2 = Before the arrival of people
3 = Arrival of people
4 = 1 hr.
5 = 2 hrs.
6 = 3 hrs.
7 = 4 hrs. At end of lesson
8 = 5 hrs.
9 = 6 hrs.
10 = Periods of [illegible]
11 = Symbols
12 = Investigations of 18 January [illegible]
" " 8 February [illegible]
" " 17 March [illegible]

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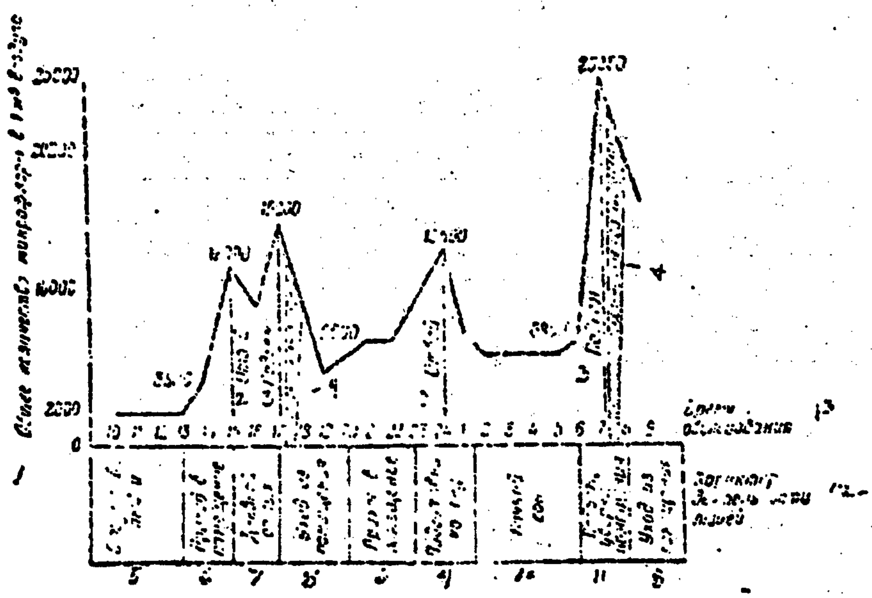

Figure 12. Bacterial contamination of the air in sleeping quarters over a 24-hour period.

Legend:

1 - total number of microorganisms in 1 m^3 of air; 2 - retreat; 3 - reveille; 4 - ventilation, 30 min.; 5 - absence of people; 6 - arrival in the room; 7 - daytime rest period; 8 - leaving the room; 9 - preparation for sleep; 10 - night sleep; 11 - reveille, cleaning of room; 12 - type of activity of people; 13 - time of examination.

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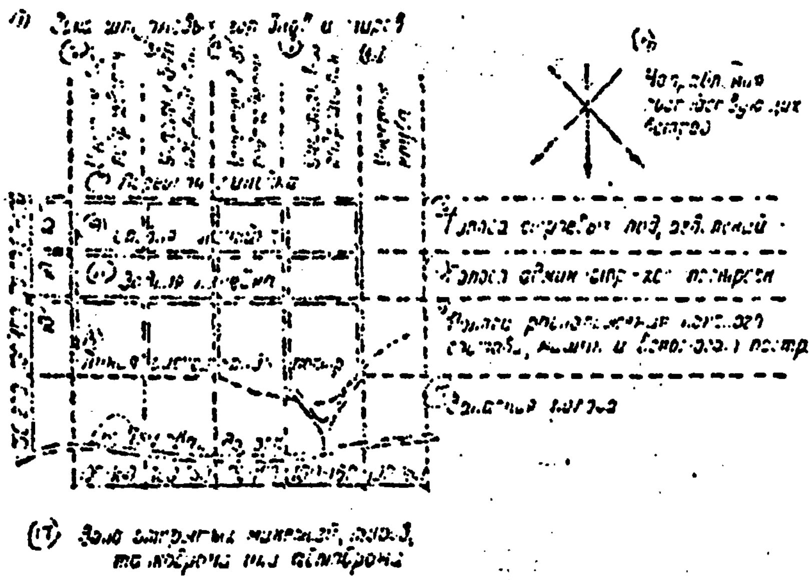

Figure 13. Layout of the camp site of a military unit.

Legend:

1 - Infantry assault training ground and rifle range
2 - Section of 4th unit
3 - Section of 3rd unit
4 - Section of 2nd unit
5 - Section of 1st unit
6 - Section of clubhouse
7 - Direction of prevailing winds
8 - Forward line
9 - Center line
10 - Strip of line units
11 - Rear line
12 - Strip of administrative-service buildings
13 - Line of outer structures
14 - Strip of horses, machines, and auxiliary structures
15 - Reserve strip
16 - Back road
17 - Zone of open riding hall, rifle range, tank park or auto park

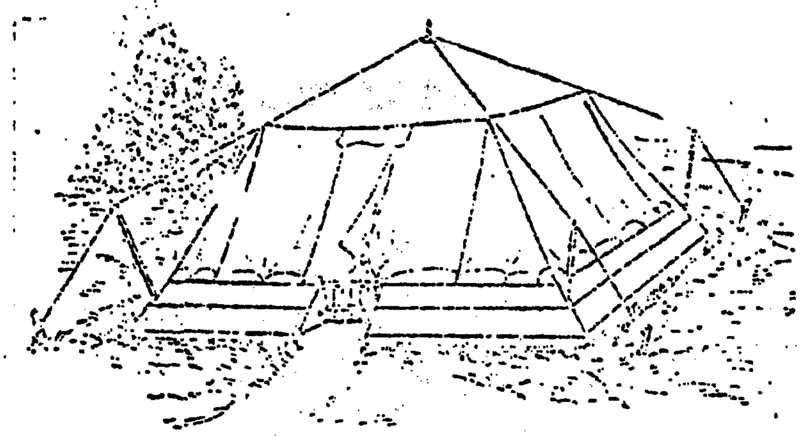

Figure 14. A heavy tent on a foundation with sloping sides.

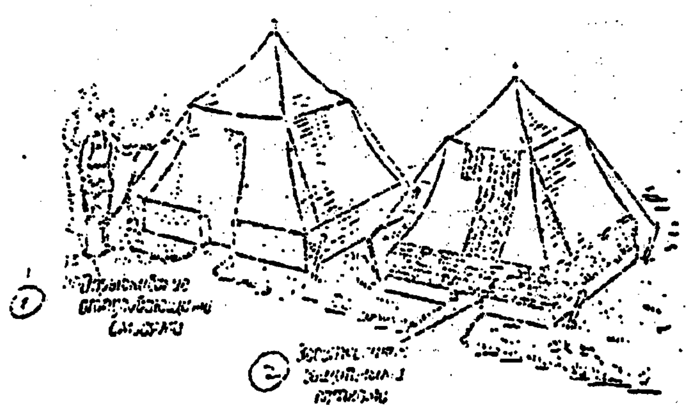

Figure 15. Use of netting on a tent and spraying of its edges to keep mosquitoes out (according to Ye. N. Pavlovskiy, G. Pervomayskiy, and [illegible] Chagin).

Legend:
1 – Spraying of repellent mixtures
2 – Use of protective netting

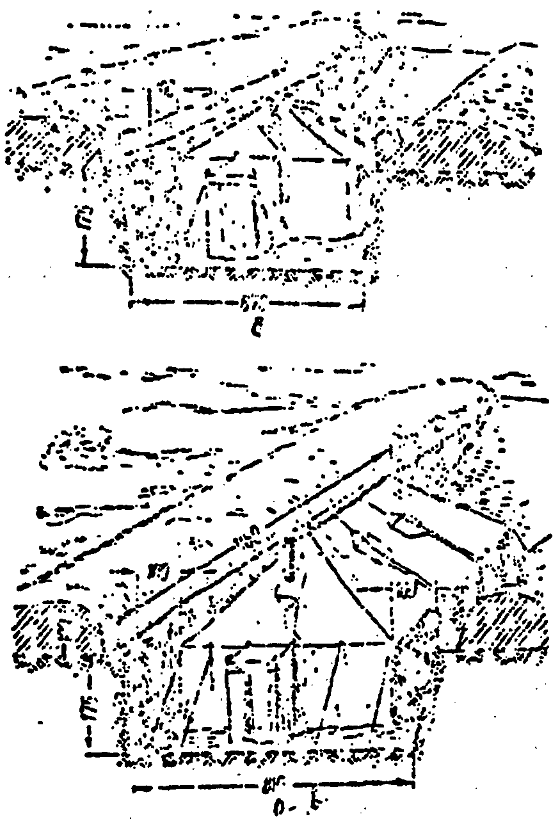

Figure 16. Tents concealed in a trench:
a - a [illegible] tent; b - a USB tent.

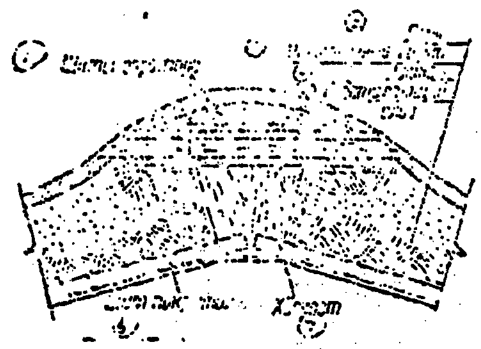

Figure 17. Dugout aerator.

Legend:
1 - [illegible] shielding; 2 - sod; 3 - packed earth; 4 - clay;
5 - underlying layer; 6 - covering shield; 7 - brushwood.

NOT REPRODUCIBLE

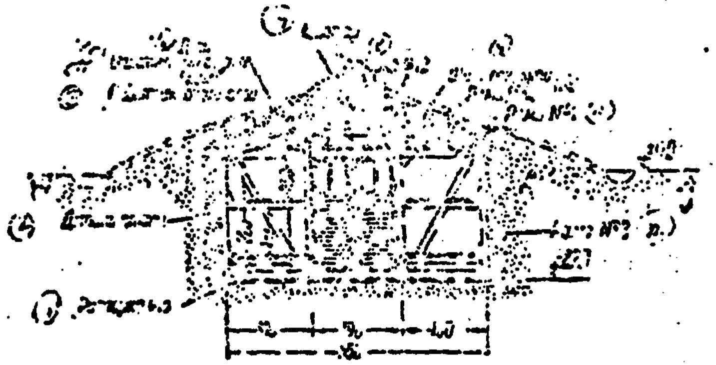

Figure 18. Diagram of a deep dugout.

Legend:

1 - tie beam P-15; 2 - wall detail; 3 - underlying layer; 4 - clay; 5 - packed earth; 6 - sod; 7 - armor; 8 - tie beam P-12; 9 - covering shield; 10 - No [illegible] frame; 11 - No 1 frame; 12 - No 2 frame.

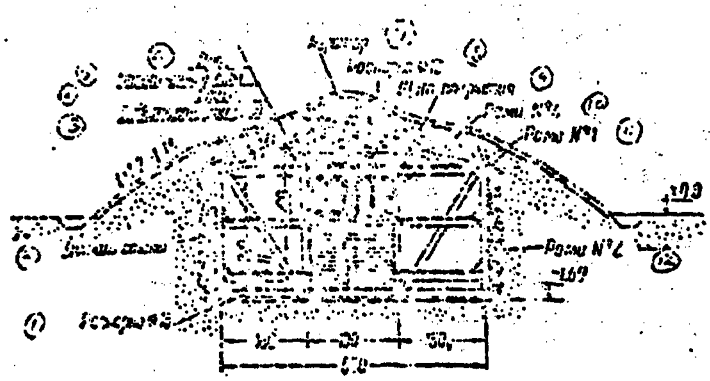

Figure 15. Diagram of a semi-deep dugout.

Legend:
1 – [illegible] 2 – [illegible] details; 3 – underlying layer; 4 – clay; 5 – ground [illegible]; 6 – [illegible]; 7 – [illegible]; 8 – tie [illegible]; 9 – covering shield; 10 – No 4 frame; 11 – No 1 frame; 12 – No 2 frame.

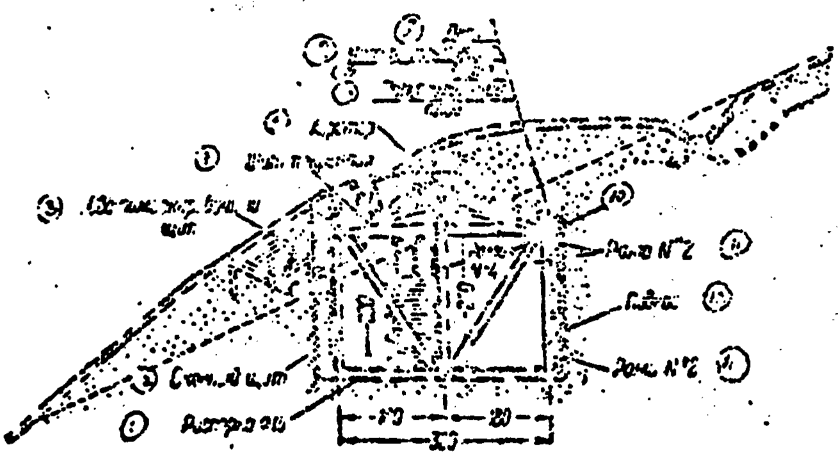

Figure 20. Diagram of hillside dugout.

Legend:

1 - tie beam P-15; 2 - window shield; 3 - light shield; 4 - covering shield; 5 - scarter; 6 - underlying layer; 7 - clay; 8 - packed earth; 9 - sod; 10 - No 1 frame; 11 - No 2 frame; 12 - brace.

NOT REPRODUCIBLE

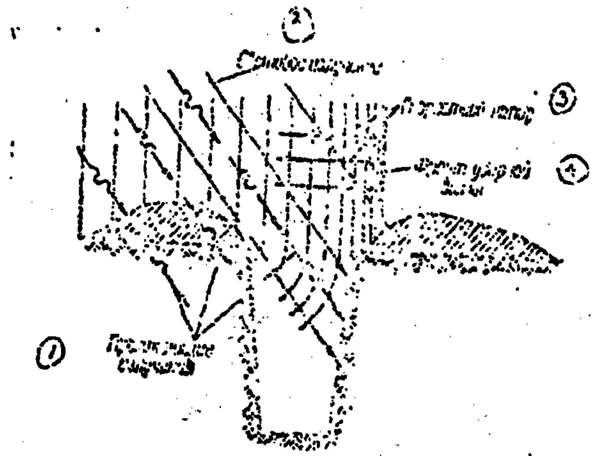

Figure 21. Defensive action of a trench.

Legend:
1 - penetrating radiation; 2 - luminous radiation;
3 - dynamic air pressure; 4 - front of shock wave.

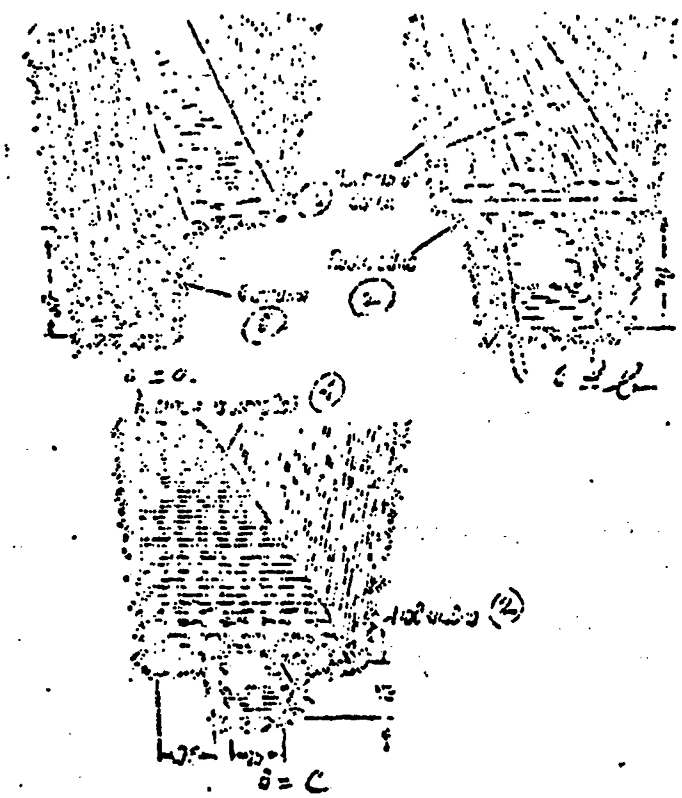

Figure [illegible]. Water drainage in trenches.
a - drainage using fascines; b - drainage ditch covered with boards; c - drainage ditch covered with poles

Legend:
1 - fascines; 2 - packing; 3 - flooring of boards; 4 - flooring of poles.

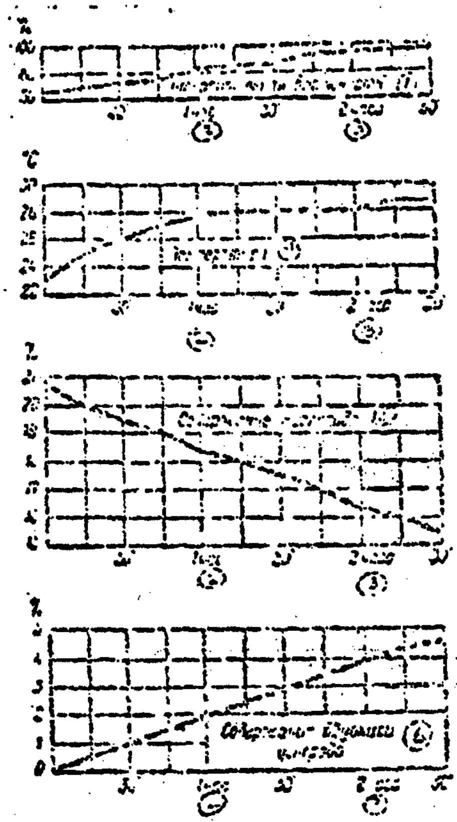

Figure 23. Changes in the composition of air in a hermetically sealed shelter.

Legend:
1 - relative humidity; 2 - 1 hour; 3 - 2 hours; 4 - temperature;
5 - oxygen content; 6 - carbon dioxide content.

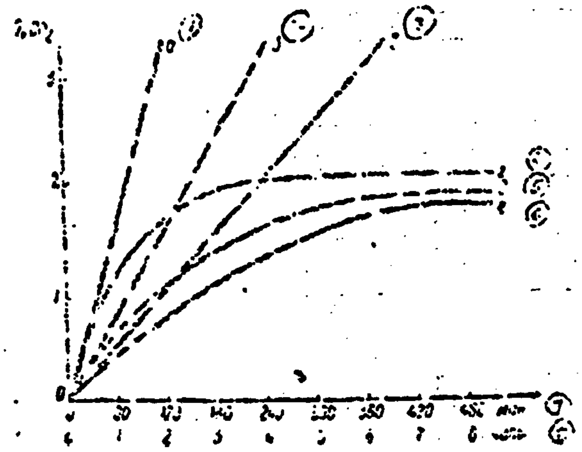

Figure 24. Accumulation of carbon dioxide in ventilated and unventilated shelters: a, b, c - no ventilation, with a specific volume of 1, 3, and 5 m^3 per man; d, e, f - with ventilation, with a specific volume of 1, 3, and 5 m^3 per man

Legend.

1 - a; 2 - b; 3 - c; 4 - d; 5 - e; 6 - f; 7 - min; 8 - hrs.

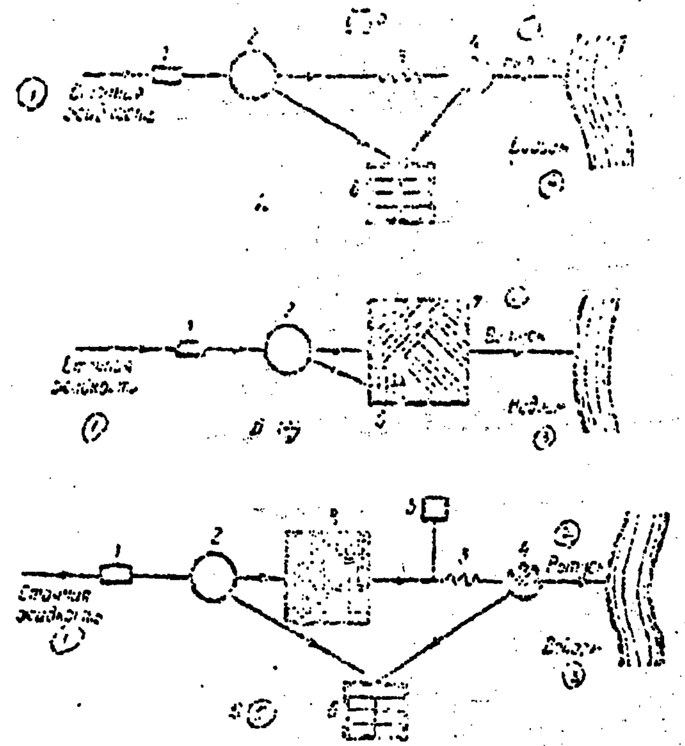

Figure [illegible]. Typical layouts of purifying [illegible].
A - layout of station for mechanical (primary) purification of sewage; B - layout of station for natural biological (complete) purification of sewage, C - layout of station for artificial biological purification of sewage; 1 - grate and sand trap; 2 - [illegible] sedimentation tank; 3 - mixer; 4 - settling basin and [illegible] sedimentation tank; 5 - chlorination; 6 - muddy grounds; 7 - irrigation or filtration fields; 8 - biological filter.

Legend:
1 - [illegible]; 2 - discharge; 3 - body of water; 4 - [illegible];
5 - [illegible].

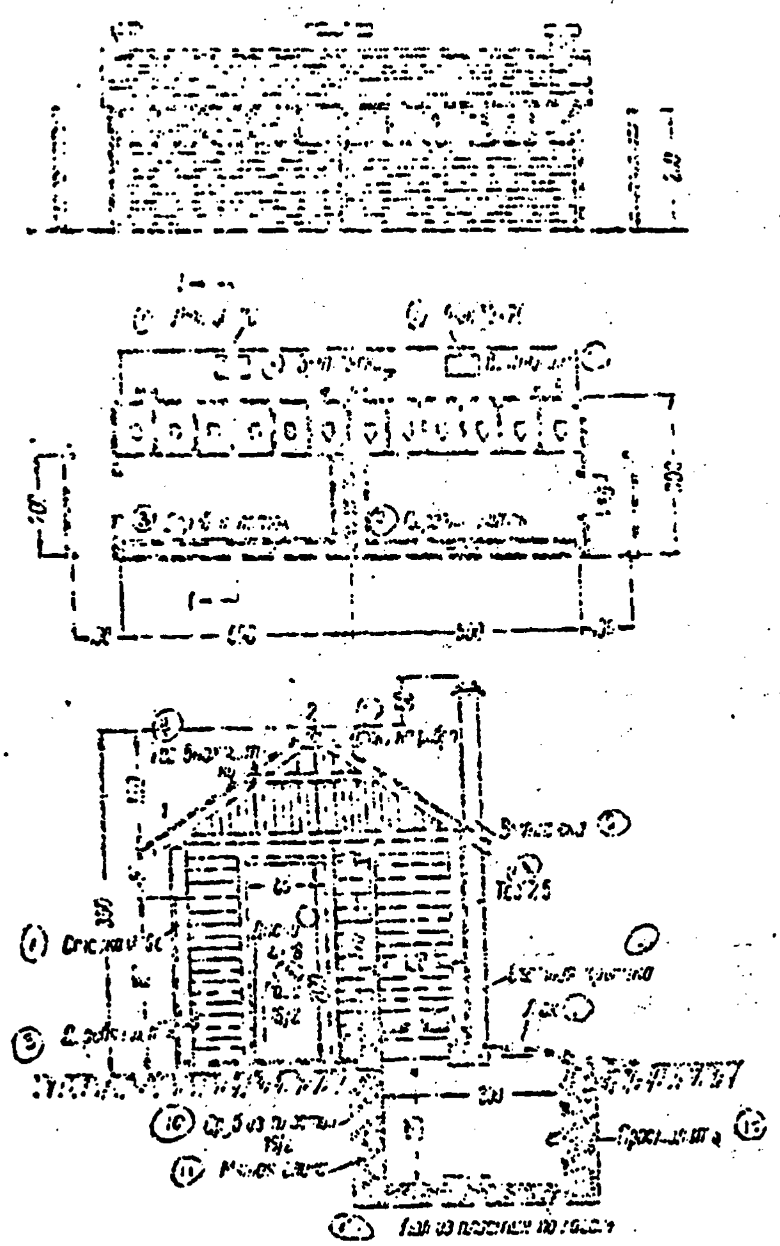

Figure 20. A camp toilet.
[Legend on following page]

Figure 26, legend:

1 – skylight
2 – [illegible]
3 – wooden trough
4 – overlapping [illegible]
5 – boards [illegible]
6 – [illegible] supports
7 – [illegible]
8 – sleepers
9 – protective cover
10 – frame of glass
11 – [illegible]
12 – to be treated with [illegible]
13 – place of [illegible] on sleepers
14 – battens

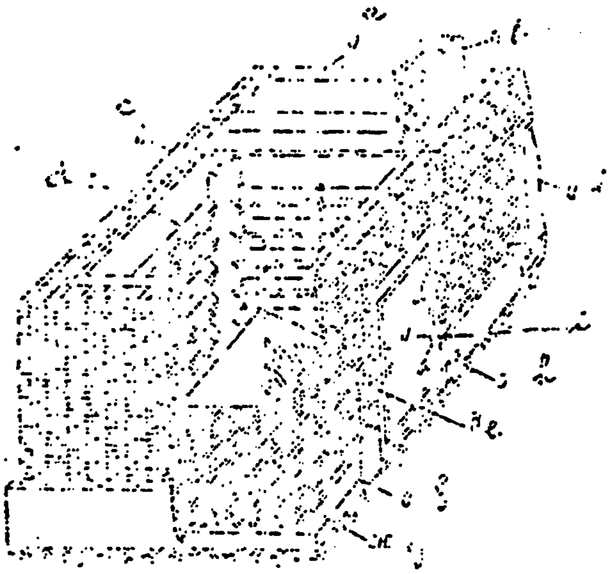

Figure [illegible]. A [illegible] chamber:
a – inside cover of the chamber; b – [illegible] pipe (tower) with small shelves; c – corner channels; d – wall projections (cornices); e – [illegible]; f – [illegible] over the floor; g – water impervious floor (bottom) of the chamber; h – air openings; i – outer door (P. V. [illegible]).

NOT REPRODUCIBLE

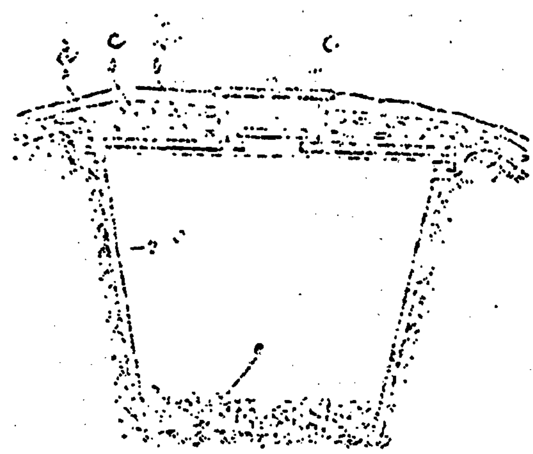

Figure 2[illegible]. Diagram of a simplified shelter built in the ground (cross section):
a - base (wood); b - upper covering (wood); c - layer of straw, leaves, etc.; d - layer of earth; d - opening for the [illegible]; e - stones, bricks, etc., on the bottom.

NOT REPRODUCIBLE

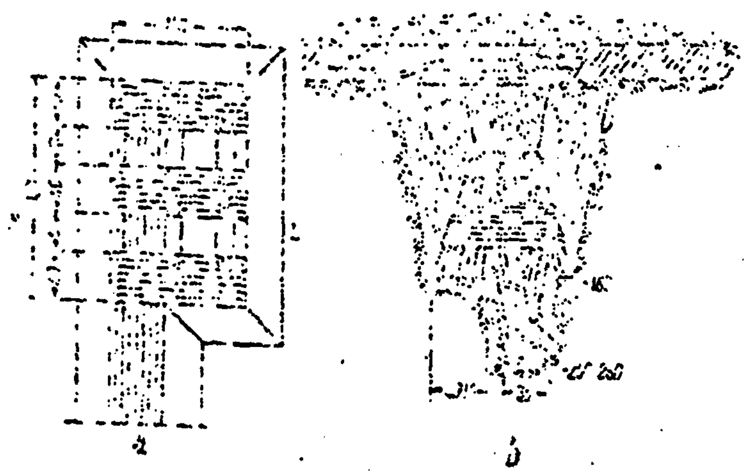

Figure [illegible] [illegible] in [illegible]:
a – [illegible]; b – [illegible] section

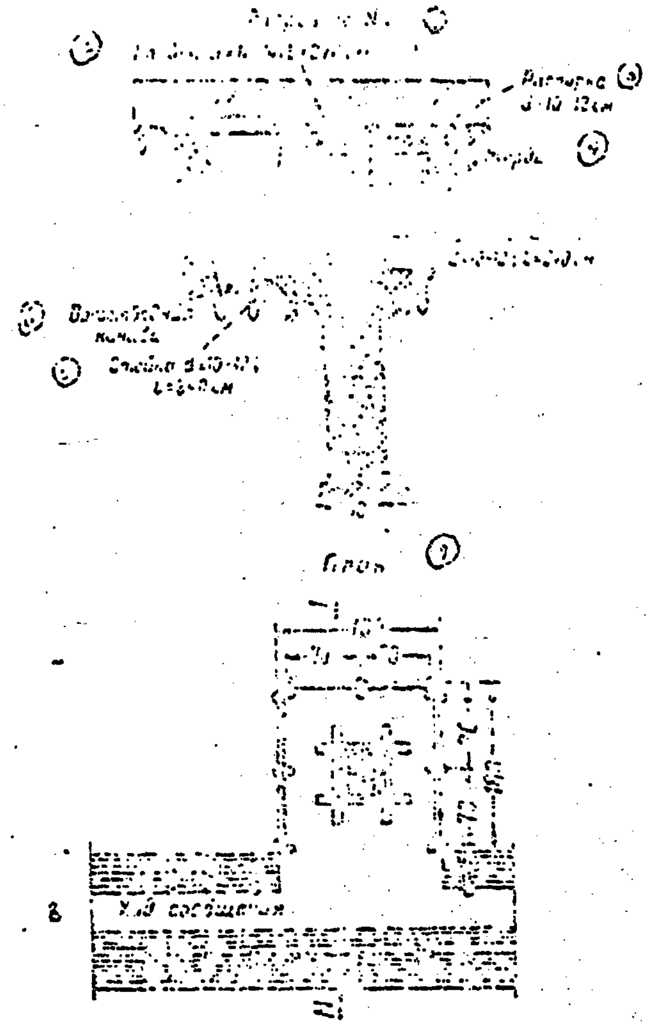

Figure [illegible]. Covering for a shaft well in the recess of a trench.

Legend:
1 - cross section from [illegible]; 2 - boards; 3 - cross bar; 4 - poles; 5 - supports; 6 - water [illegible]; 7 - plan; 8 - communication trench

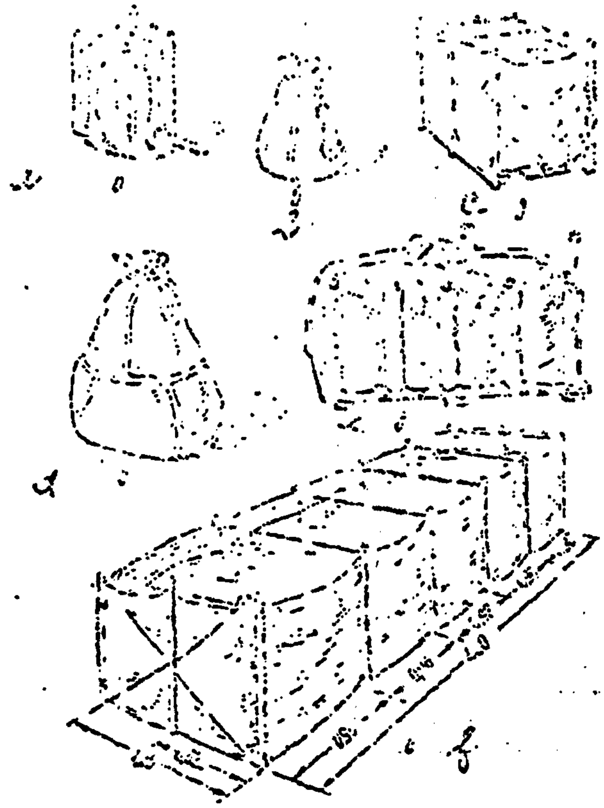

Figure 31. Authorized receptacles for storing water.
a - neck-barrel, 100 liter capacity ([illegible]-100); b - neckless barrel, 100 liter capacity ([illegible]-100); c - receptacle, 1,000 liter capacity ([illegible]-1000); d - neckless receptacle, 1,000 liter capacity ([illegible]-1000); e - rectangular tank, 1,000 liter capacity ([illegible]); f - receptacle, 6,000 liter capacity ([illegible]-6000).

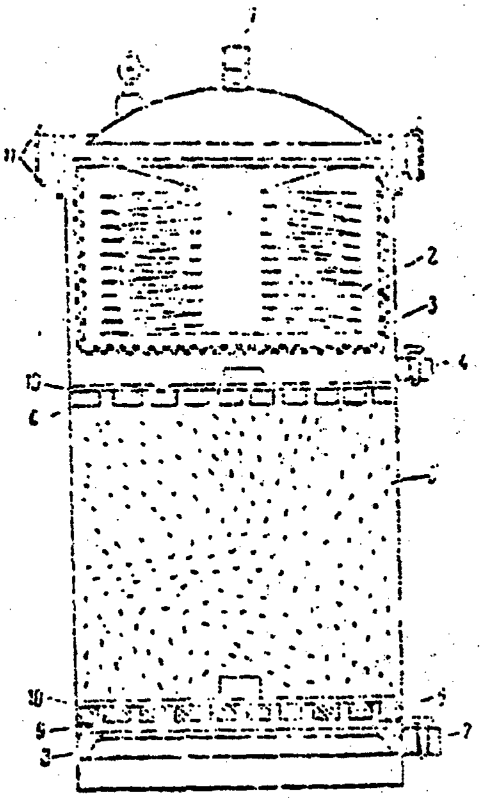

Figure 30. Cloth-carbon filter TUF-20:
1 - introduction of chlorinated and coagulated water; 2 - cloth sack; 3 - willow crib; 4 - cock for removal of filtrate after passage through cloth sack; 5 - activated carbon; 6 - perforated disc (upper and lower); 7 - cock for removal of filtrate after passage through TUF; 8 - ring support; 9 - rubber gasket; 10 - sieve; 11 - rubber gaskets.

NOT REPRODUCIBLE

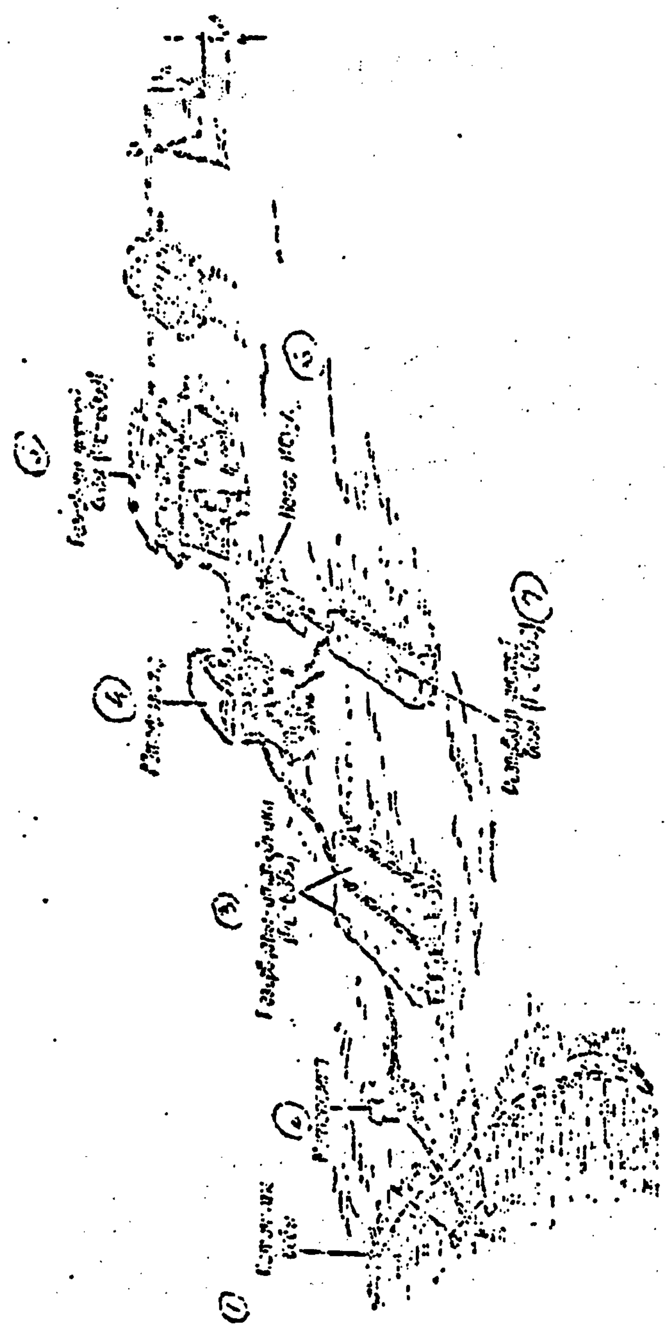

Figure 53. Diagram for setting up a truck filter plant ([illegible]S-5000).
[Legend on following page]

Figure [illegible], legend:

1 - source of water; 2 - [illegible] pump; 3 - sedimentation tanks (R[illegible]-[illegible]); 4 - brook filter; 5 - pure water tank ([illegible]); 6 - pump [illegible]; 7 - pure water tank ([illegible]).

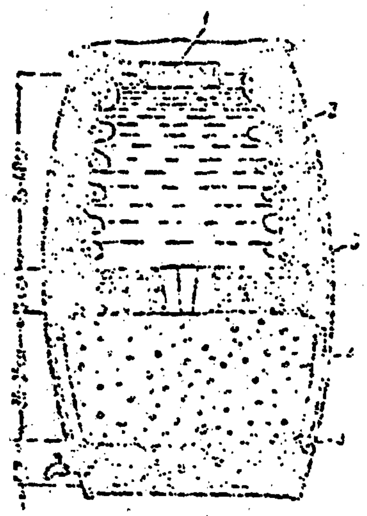

Figure [illegible]. Cloth-carbon filter:
1 - [illegible]; 2 - cloth sack 1.5 to 2 m long (pleated); 3 - brushwood 0.5 to 1 cm in diameter; 4 - carbon in cloth sack.

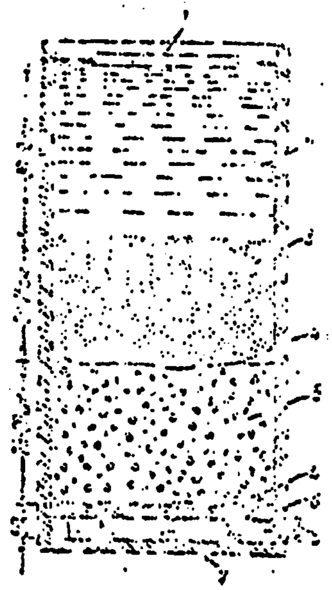

Figure 35. Sand-carbon filter:
1 - bucket; 2 - water, 3 - sand 0.5 to 2 mm in size; 4 - cloth;
5 - charcoal or activated carbon 0.5 mm in size; 6 - perforated bottom; 7 - bottom supports.

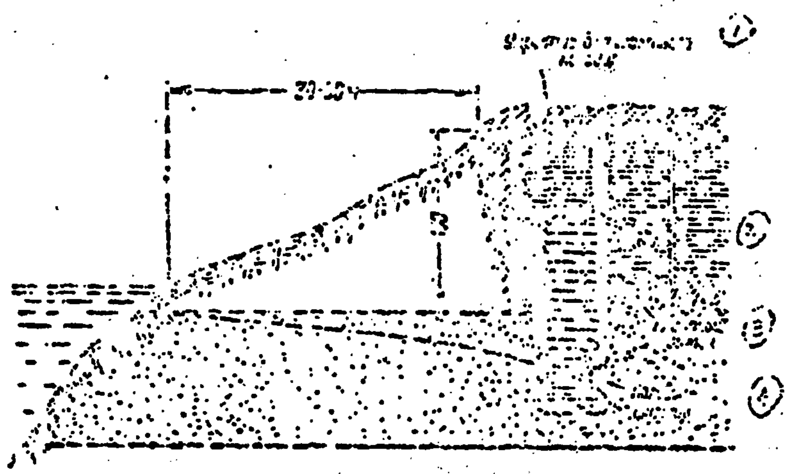

Figure 36. Obtaining water from a stream by means of a filter well.
1 - covering for a shaft well; 2 - hand pump; 3 - clay seal;
4 - well filter.

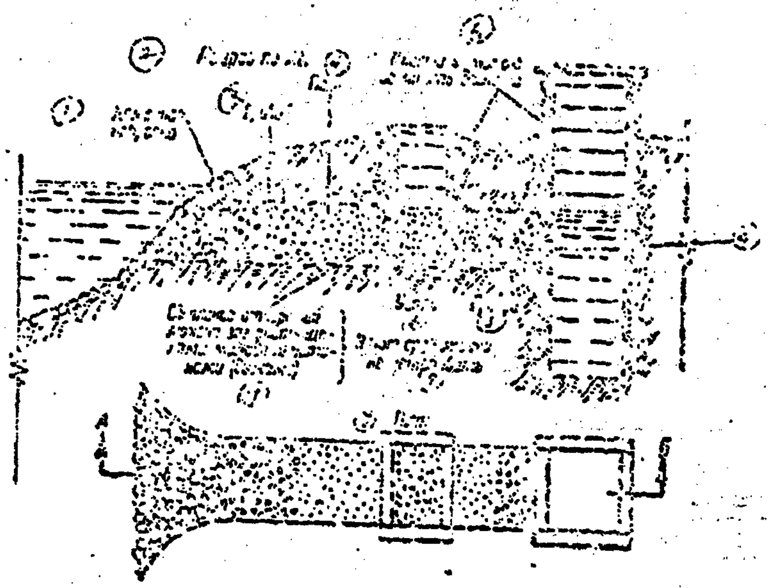

Figure 37. Filter trench.

Legend:
1 - [illegible]; 2 - cross section from A to B; 3 - gravel; 4 - sand; 5 - [illegible] can be used instead of [illegible]; 6 - [illegible]; 7 - cracks can be used between slabs (boards) instead of boring holes; 8 - [illegible].

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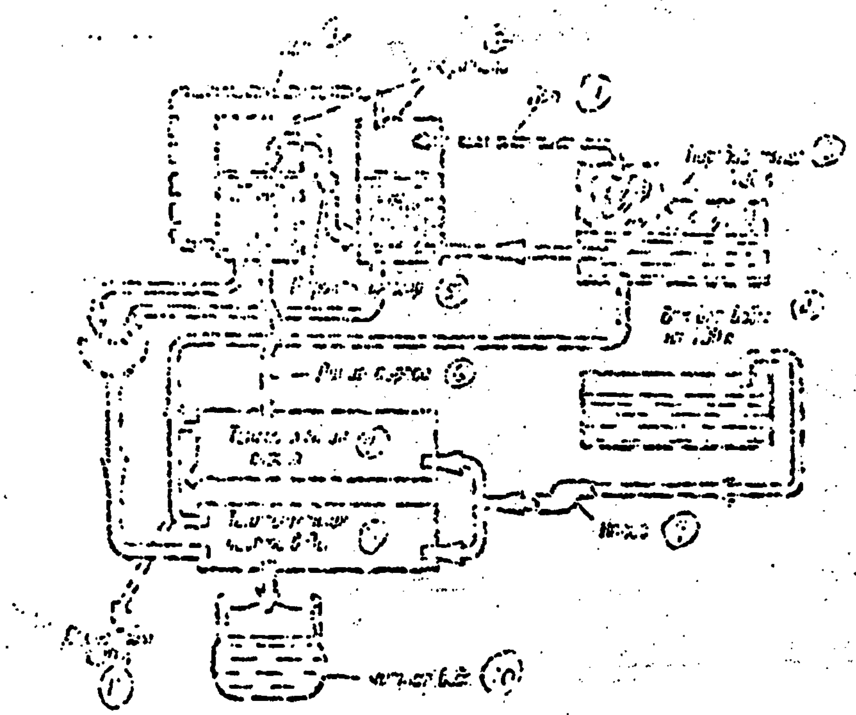

Figure 3[illegible]. Diagram of the operation of a portable distiller (according to V. [illegible] and [illegible]).

Legend:
1 - [illegible]; 2 - [illegible]; 3 - steam boiler, 700 liters; 4 - water tank, 700 liters; 5 - steam compressor; 6 - waste liquid discharge; 7 - heat exchanger of waste liquid; 8 - heat exchanger of pure water; 9 - pump; 10 - pure water; 11 - waste liquid, 400 liters.

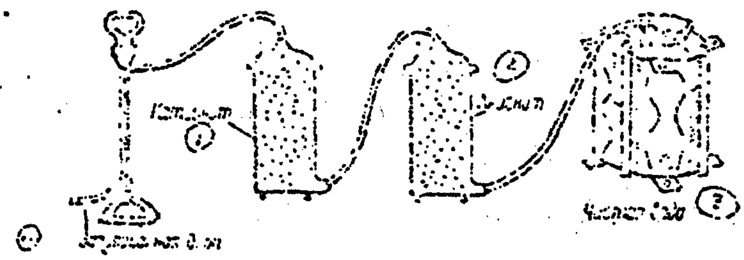

Figure 39. Diagram of water decontamination by the ion-exchange method using a TUF-200 (according to V. Rungkin and N. Shuvayev).

Legend:
1 - cationites; 2 - anionites; 3 - pure water; 4 - polluted water.

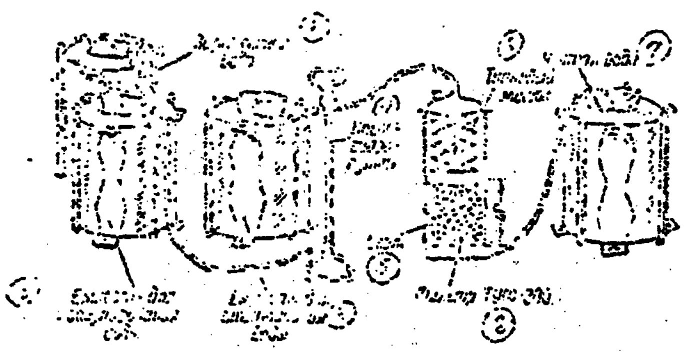

Figure 40. Diagram of water decontamination by coagulation, sedimentation, and filtration using a TUF-200 (according to V. Rungkin and N. Shuvayev).

Legend.
1 - polluted water; 2 - container for coagulating water; 3 - container for settling of water; 4 - hydraulic pump; 5 - carbon; 6 - cloth sacks; 7 - pure water; 8 - TUF-200 filter.

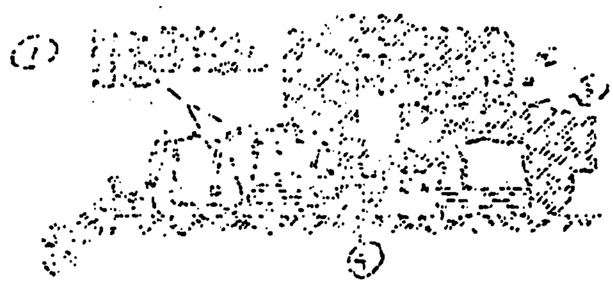

Figure 13. Diagram of water decontamination [illegible] by the [illegible] method using an ARS-[illegible] (according to V. [illegible] and N. [illegible]).

Legend:
1 - ARS-[illegible] receptacle to receive, coagulate, and settle infected water; 2 - [illegible], 40 cm; 3 - [illegible], 50 cm; 4 - gravel and sand, 20 cm.

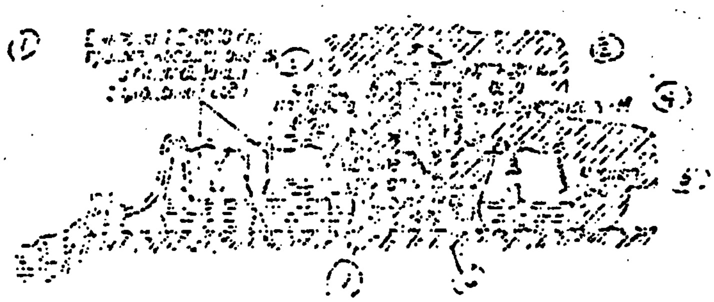

Figure 14. Diagram of water decontamination by filtration through [illegible] using an ARS-[illegible] (according to V. [illegible] and [illegible]).

Legend:
1 - ARS-[illegible] receptacle to receive, coagulate, and settle infected water; 2 - flange for waste water; 3 - infected water; 4 - [illegible]; 5 - pure water; 6 - sand and gravel; 7 - gear pump.

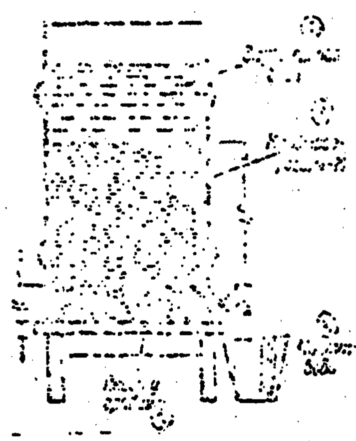

Figure [illegible]. Decontamination of water using a filter made from locally available materials.

Legend.
1 - infected water; 2 - [illegible]; 3 - pure water; 4 - sand and gravel.

NOT REPRODUCIBLE

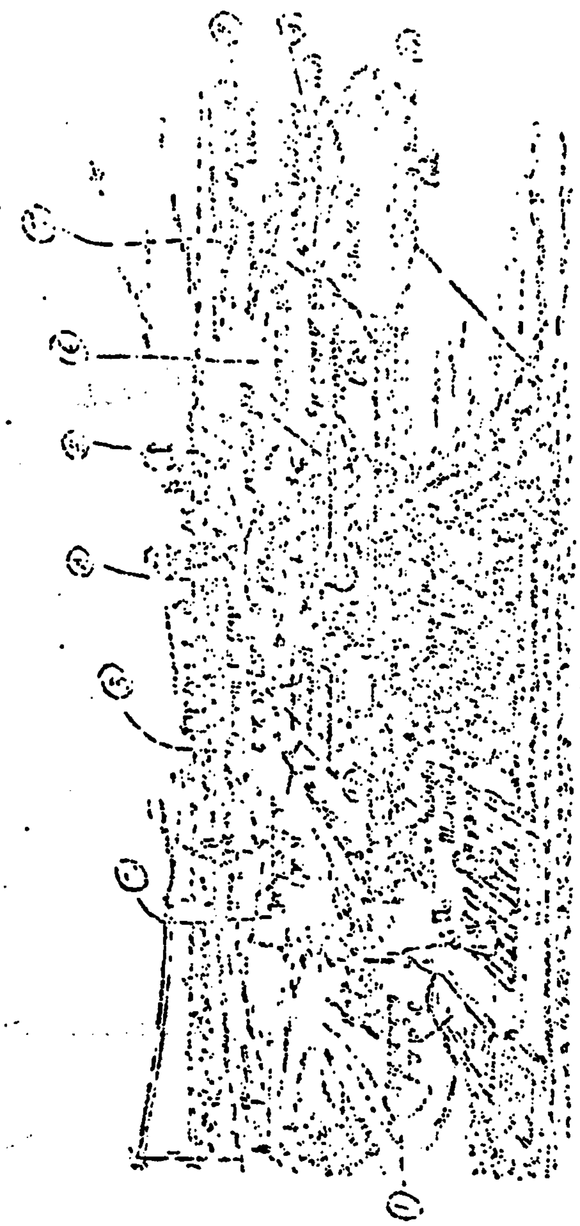

Figure 14. Water supply point with decontamination area.
(Legend on following page)

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Figure [illegible] [illegible].

[illegible] = [illegible]; [illegible] = [illegible]; [illegible] = [illegible] [illegible] with [illegible]; [illegible] = [illegible]; [illegible] = field laboratory; [illegible] = [illegible]; 7 = [illegible] with [illegible] water; [illegible] = [illegible]; [illegible] = [illegible] water; 10 = [illegible]; [illegible] = [illegible] of [illegible] water; 12 = dirty area; 13 = clean area.

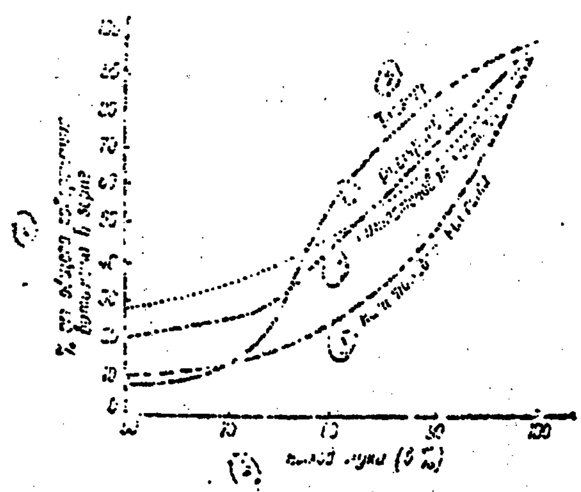


Figure [illegible]. [illegible] between flour yield and the content of B-complex vitamins (according to [illegible]).

[illegible]:

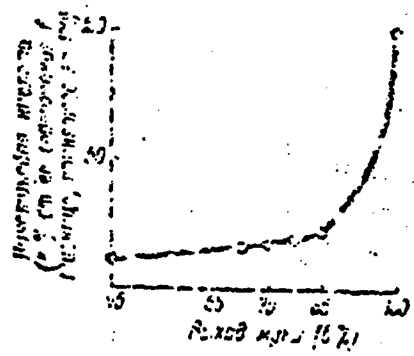
[illegible] = [illegible] in [illegible] grain; 2 = thiamine; 3 = riboflavin; [illegible] = [illegible] acid; [illegible] = flour yield (in %).

Vitamin B_1 (as a % of its content in [illegible])

Flour yield (as a %)

Figure 46. Relationship between flour yield and vitamin B_1 content (according to [illegible]).

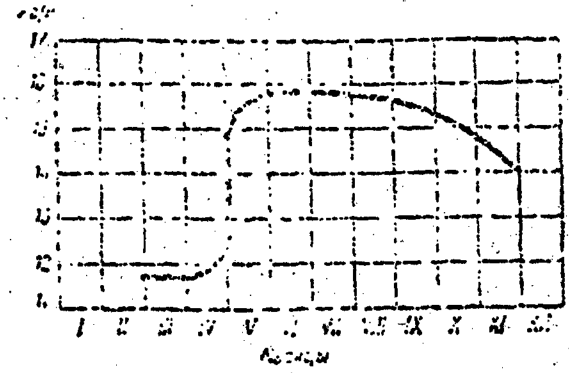
Nicotinic acid (as a % of its content in wheat taken as 100)



Flour yield (as a %)

Figure 47. Relationship between flour yield and content of vitamin PP (according to V. L. [illegible]).

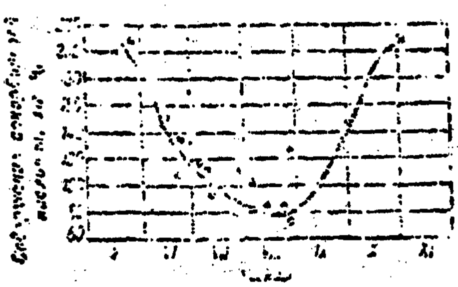
mg/l



Months

Figure 18. Seasonal variations in the vitamin C content of cow's milk (according to A. N. [illegible]).

Ascorbic acid content, mg%



Months

Figure 19. Seasonal changes in vitamin C activity of coniferous needles (according to [illegible] Kir[illegible]).

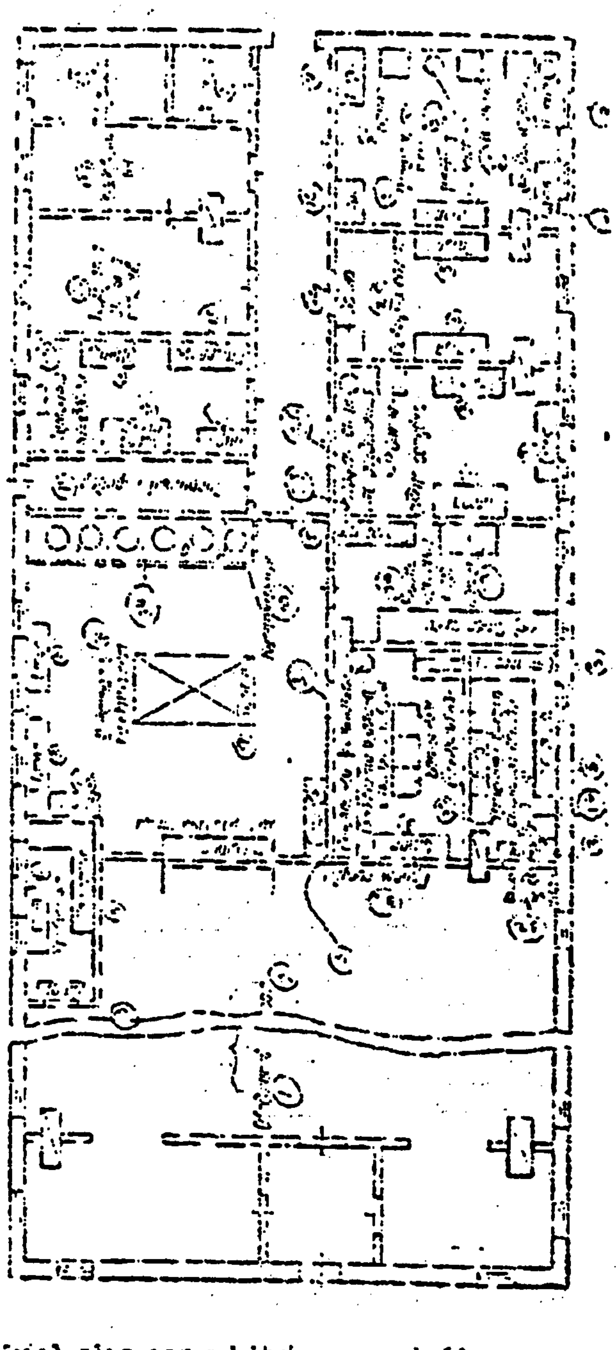


Figure 50. Model plan for a kitchen-mess hall.
[Legend on following page]

Figure 50, [illegible]

1 - [illegible]; 2 [illegible] 4 - [illegible]; 5 - [illegible];
6 - [illegible] 7 - [illegible]; 8 - [illegible] and
distributing; 9 - [illegible] 10 - [illegible]; 11 - [illegible];
12 - pantry; 13 - [illegible] 14 - [illegible] 15 - [illegible]; 16 - [illegible]
room for cooks; 17 - dressing room; 18 - shower; 19 - toilet;
20 - tub; 21 - [illegible]; 22 - potato peeling; 23 - [illegible];
24 - vegetable cutting; 25 - fish dividing; 26 - chopping [illegible];
27 - meat dividing; 28 - meat grinding; 29 - washing of kitchen
utensils; 30 - storage and distribution of tableware; 31 - pantry;
32 - distribution of dishes; 33 - toilet; 34 - washing and drying
of tableware; 35 - [illegible].

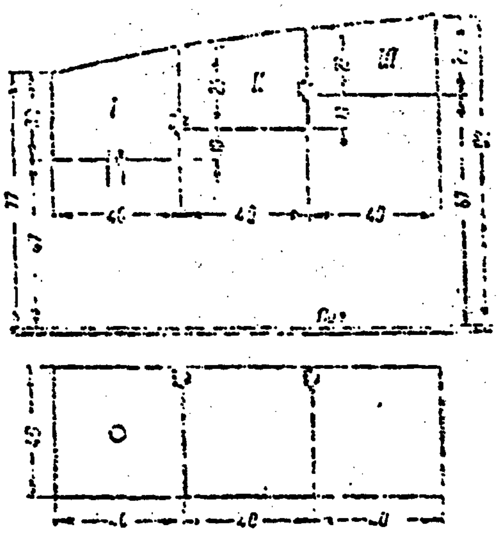
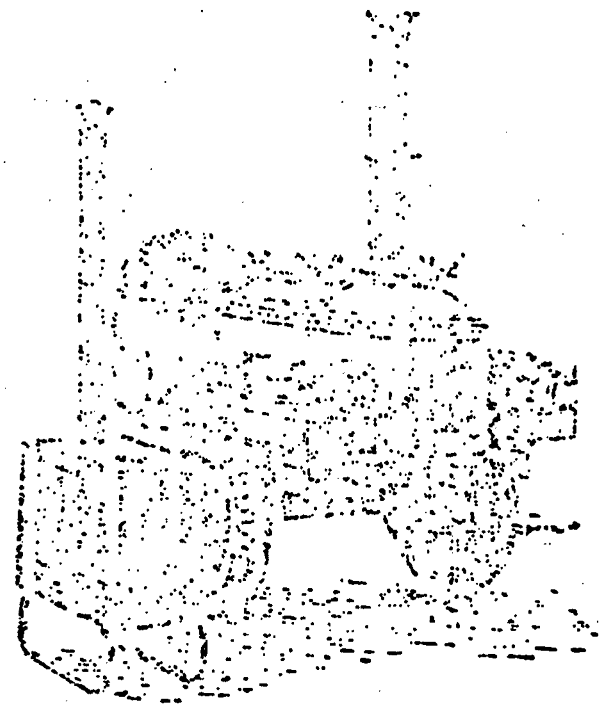
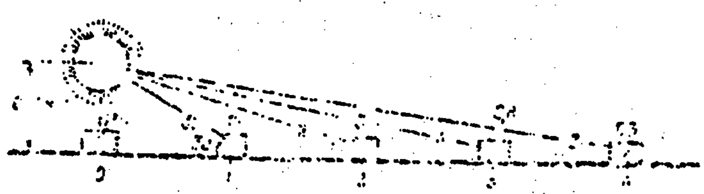


Figure 5[illegible]. Diagram of a [illegible] wash tub.

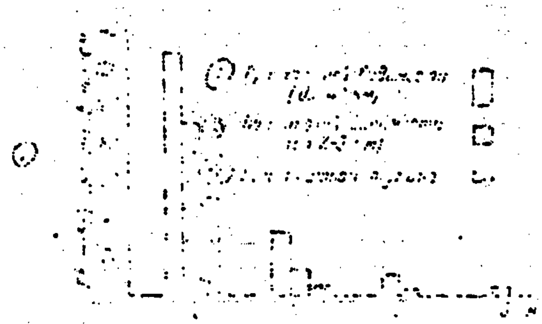


[illegible]



[illegible]

Figure [illegible]



[illegible]

[illegible]

L[illegible]gend[illegible]

[illegible]

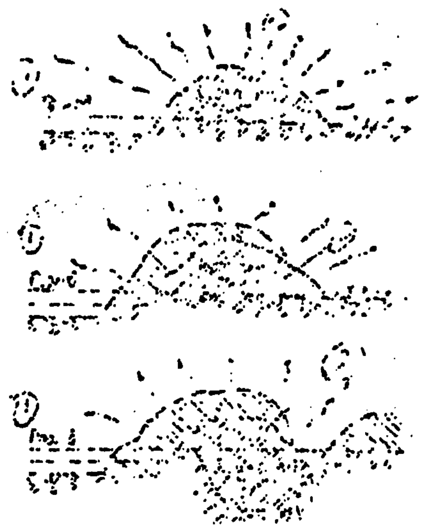


Figure 55. A method of preventing contaminated ground from causing injury

Legend:
1 - [illegible]; 2 - contaminated ground.

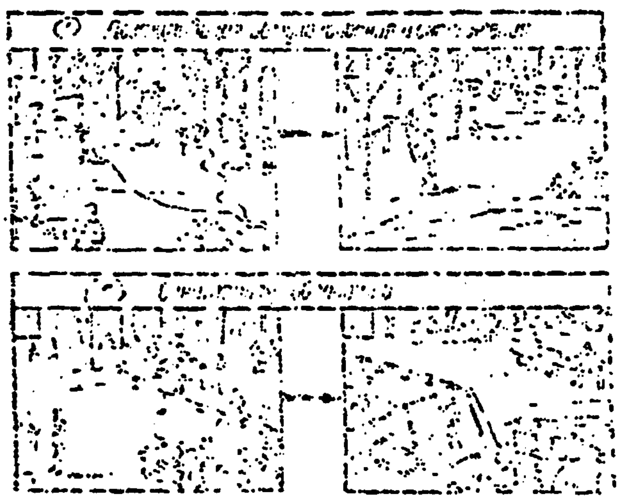
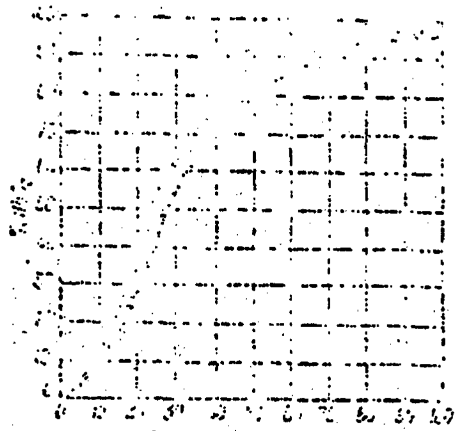
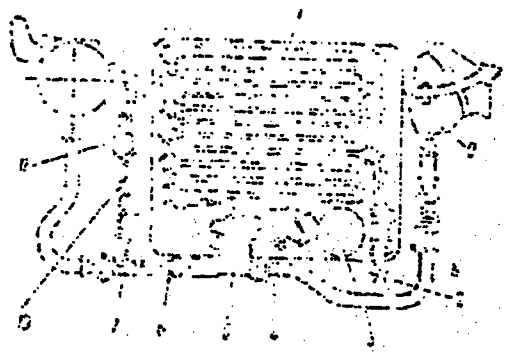


Figure 56. Decontamination of uniforms and equipment and sanitary processing.

Legend:
1 - decontamination of uniforms and equipment; 2 - sanitary processing.





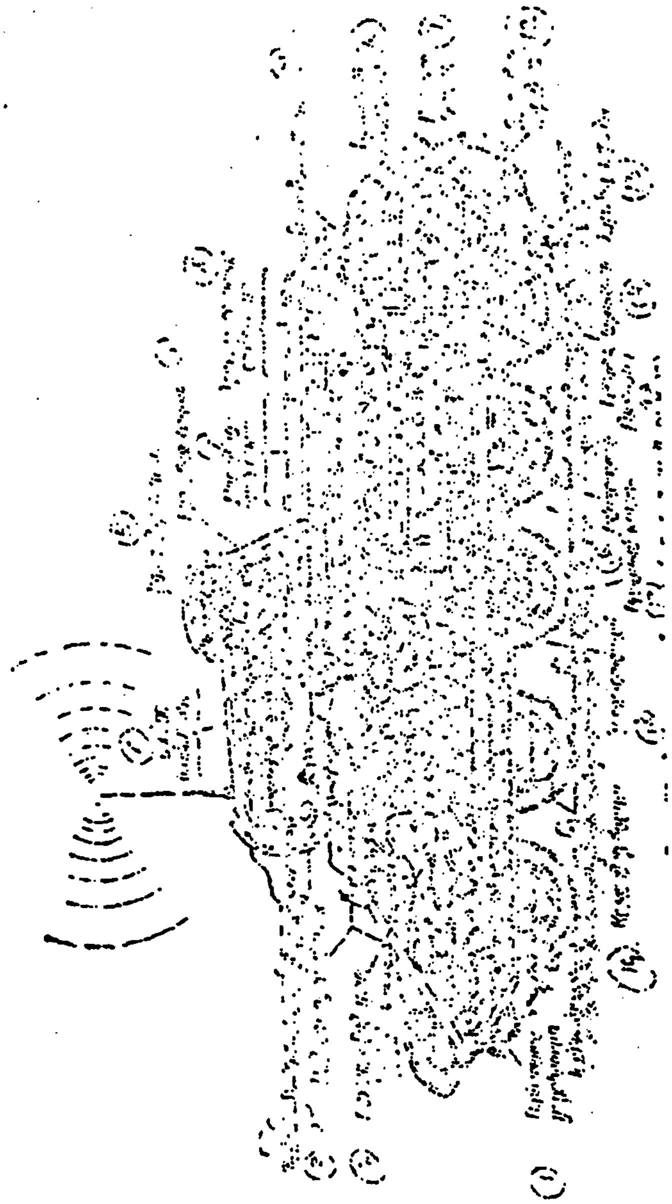


Figure 59. A motor unit (longitudinal section).
[Key is on following page]

NOT REPRODUCIBLE

Figure [illegible] Legend:

[illegible] - [illegible]; 3 - [illegible] gunner;
[illegible]; 6 - armored turret;
7 - [illegible]; 8 - transmission compartment; 9 - armored
[illegible]; 10 - [illegible]; 11 - [illegible] wheel; 12 - side
[illegible]; 13 - [illegible]; 14 - main clutch; 15 - tracks;
16 - engine; 17 - [illegible]; 18 - loader; 19 - turret commander.

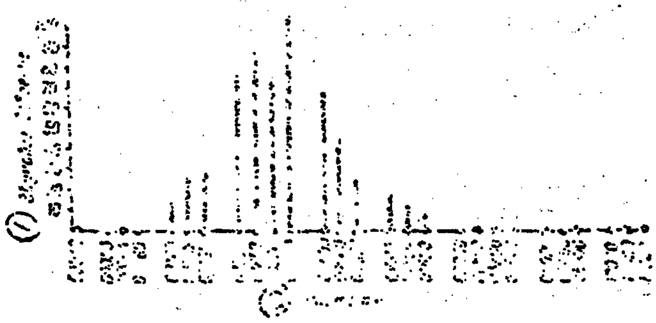


Figure [illegible]. [illegible]

Legend:
[illegible]

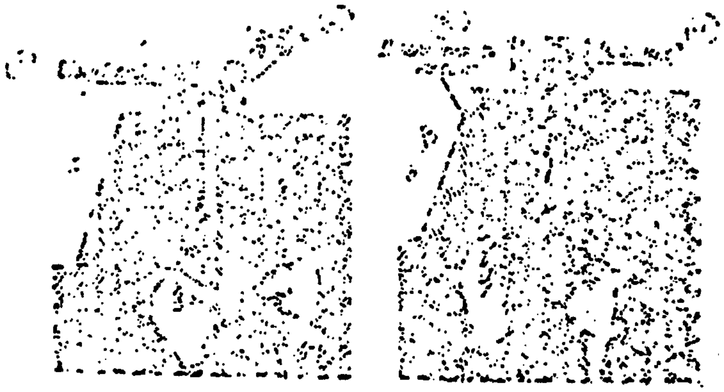


Figure [illegible]. [illegible]

[illegible]

[illegible]